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AT
HOLLENDEN HOTEL
CLEVELAND, O.
OCTOBER 2-6, 1922

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STREET LIGHTING AND PUBLIC SAFETY

By Earl A. Anderson, Illuminating Engineering Staff, National Lamp Works of General Electric Company, Cleveland, O.

Developments in artificial lighting have been applied in interiors to the extent that today business occupations, industries, sports, and social engagements in cities are carried on in the evening with the same degree of profit and pleasure as by daylight. These developments have, however, been so rapid, that their application in street lighting has fallen behind, and in comparatively few cities is the degree of artificial street lighting adequate to accomplish fully its purpose of facilitating safe, comfortable, and convenient usage of the streets. It is significant that in the past few months interest in street lighting has been developing rapidly. Particularly has attention been directed to the relation between street lighting and public safety.

Street Lighting and Traffic Accidents

The seriousness of accident hazard on streets of American cities as a factor to be reckoned with in every-day life becomes evident from even a casual inspection of statistics, which show the losses incurred in this continuous waste of life, time, and property. For example, in a recent paper Simpson[1] gave figures showing 25,000 fatal industrial and 2,000,000 total industrial accidents annually causing lost time of a total cost of $2,000,000,000 or a cost averaging $1,000 per accident. The total annual fatal accidents from all causes including industrial are estimated to be 75,500 from statistics compiled by Dr. Crum,[2] and of these approximately 7,800 are railway and 15,500 are street traffic accidents. Therefore, the loss of life in traffic accidents is twice as great as in railway accidents and equal to over half the total industrial loss.

As to an evaluation of the annual personal and property loss from automobile accidents in terms of money, Dr. Crum states that while an accurate computation is not possible, the annual sacrifice is fully $1,000,000,000. This figure appears very reasonable when one considers that in the survey of traffic accidents numbering 800 fatalities reported in this paper there were 31,000 other accidents of sufficient severity to be reported to the police and also that personal injuries were sustained in approximately one-half of these cases.

To the development of high-speed traffic brought about by the very extensive adoption of automobiles must be charged practically all of the increase in street-traffic accidents. In 1906 there were less than 400 deaths in the United States from automobile accidents, while in 1920 the total was greater than 10,000, representing an increase of some 2,500 per cent. Further, as shown by the curve of Fig. 1, this total is mounting steadily.

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[1] R. E. Simpson, Travelers Insurance Co., I.E.S. Transactions, Vol. XV, No. 8.

[2] F. S. Crum, Statistician, Prudential Insurance Co., Automobile Fatalities.

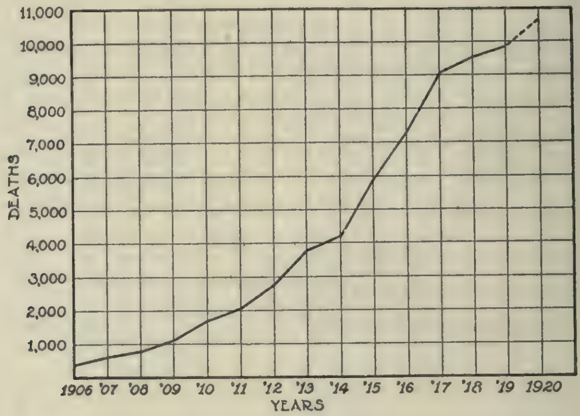

Fig. 1—*Deaths from Automobile Accidents by Years*

In recent years efforts have been directed toward reducing the accident rate by more stringent traffic regulations and by widespread educational publicity work on the part of safety organizations. Definite evidence of the value of such safety measures may be seen in statistics which show a check in the growth of the accident rate in those cities and localities where the most careful attention has been given to the development of accident-prevention efforts.

The figures presented by Dr. Crum show that at least two-thirds of all traffic accidents have occurred in cities of 10,000 inhabitants or more, and on this basis it would appear that the traffic-accident problem is of greatest immediate importance in these larger communities. It is worthy of note, however, that the increasing amount of inter-city touring has brought a heavy highway traffic to villages of even the smallest size and it is, therefore, apparent that even in smaller communities public safety demands an increased attention toward means for reducing the street-traffic-accident hazard.

Facts Brought Out by Street Lighting Survey

With the purpose of collecting definite data regarding the value which should be attributed to the proper illumination of streets as a factor in the prevention of traffic accidents, a survey of the traffic accidents in a representative group of cities was conducted by the Engineering Department, National Lamp Works.[3] In order to obtain as high a degree of uniformity as possible in the collection of the data, blank forms were prepared providing for a charting of all traffic accidents in a given city during the period of one year, and for distributing them as to the month and hour of the day at which each occurred, with notations as to whether or not the accident resulted in a fatality. Thru the cooperation of officials and of individuals interested in accident prevention, tabulated reports in a form to be directly applied were obtained from 32 cities with a combined population of over 7,000,000.

From each of these cities the report covered a full year's accidents; in most cases during the period from the middle of 1919 to the middle of the year 1920. The names of the cities and an abbreviated summary of the data for each city are given in Table I. The total number of street-traffic accidents reported for one year in these 32 cities was 31,475 of which 9,534 or 30.3 per cent occurred during hours of darkness. It was anticipated that there might be considerable variations in conditions existing in individual cities located in different states and it was, therefore, particularly desired to obtain a sufficiently diverse group of cities including a large enough total of population to give the presumption of a reasonable degree of accuracy in the results.

The 31,475 traffic accidents are charted in Fig. 2, according to the total number during each month. In certain cities special local influences, such as an excess of traffic at some one season of the year, changed the distribution of accidents considerably, but in most cases the individual reports adhered to the trend shown by the average curve in Fig. 2. At first thought it is

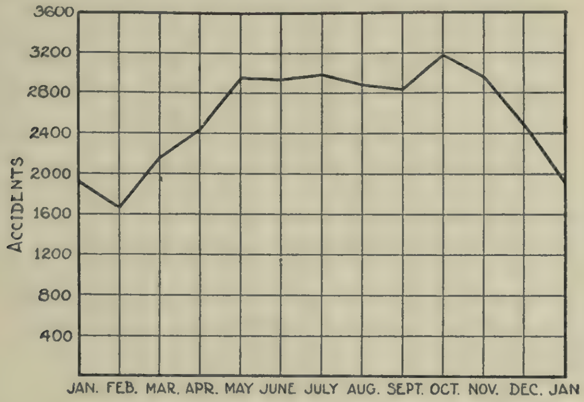

Fig. 2—*Traffic Accidents by Months*

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[3] Earl A. Anderson and O. F. Haas, Illumination and Traffic Accidents, I.E.S. Convention, 1921.

somewhat surprising to note that there were a greater number of accidents in the summer months than in winter as there are a number of influences which tend to increase the hazard in winter, such as stormy, foggy weather, slippery streets, and the impediment of heavy clothing. However, as a matter of fact, the traffic is so much greater during summer months than in winter that even in spite of the unfavorable conditions in winter the accident total is greater in the summer than in the winter months in most cities.

The total accidents reported for the year are charted in Fig. 3 according to the hour of the day during which they occurred. This chart also shows the apparent importance of density of traffic as a factor in causing accidents. It will be noted that relatively few accidents are reported in the hours from 1 to 7 o'clock in the morning, the period of the day in which street traffic is least. On the other hand, the accident rate becomes greatest in the hour from 5 to 6 in the afternoon when in practically every city the streets are congested with the home-going population from offices, stores and factories.

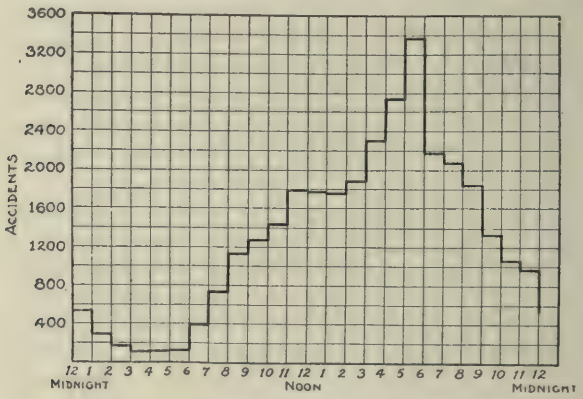

Fig. 3—*Traffic Accidents by Hours*

In determining how many of the 9,543 accidents which occurred after dark would have been avoided had daylight or its equivalent been available, it is evident that a ratio between the accidents occurring from the hours 6 to 8 p.m. in summer as against the number that occur during the corresponding hours in winter would not directly show the influence of light because of the numerous other variables referred to above which have an influence that must be taken into account.

Fortunately, the accident statistics for the hours of the day which are light in both summer and winter or which are dark in both summer and winter offer a convenient means for determining a correction factor to take into account the variables other than light which affect the number of traffic accidents in winter and summer. The periods of 3 to 5 p.m. and 9 to 11 p.m. are the logical selections because of their adjacency and the consequent similarity of traffic to that in the 6 to 9 p.m. period. In Table I are shown the data on accidents by cities and the totals for the respective periods of 3 to 5 p.m., 6 to 8 p.m. and 9 to 11 p.m., separated so as to show the number of accidents during these hours in the "summer" months of May, June and July, and the "winter" months of November, December and January.

Table No. I

Traffic Accident Statistics for Thirty-two Cities During a Period of One Year. Traffic Accidents Reported

			Total	Night	3–5 p.m.		9–11 p.m.		6–8 p.m.	
	Total	Night	Fatal	Fatal	Winter*	Summer	Winter*	Summer	Winter*	Summer
Philadelphia, Pa....	5231	1485	190	66	175	251	71	98	164	183
Cleveland, Ohio.....	3549	1059	174	56	120	120	89	73	154	121
Boston, Mass.......	3380	1001	89	38	108	159	57	69	117	131
Pittsburg, Pa.......	2950	982	6	2	119	183	57	100	74	109
San Francisco, Cal..	3014	1092	76	32	127	106	58	73	110	84
Jersey City, N. J....	672	223	28	13	18	38	8	17	36	32
Rochester, N. Y....	2570	735	29	9	70	111	34	71	62	119
Portland, Oregon....	1230	411	31	8	45	43	11	21	38	48
Columbus, Ohio.....	193	95	17	9	7	11	6	13	8	7
Hartford, Conn.....	1389	300	19	6	38	72	12	17	37	57
Grand Rapids, Mich.	255	78	12	4	9	8	1	7	10	12
Youngstown, Ohio...	702	258	33	15	33	31	12	17	28	25
New Bedford, Mass.	699	189	7	3	34	40	6	17	20	31
Lynn, Mass........	818	278	7	2	35	40	19	20	36	42
Utica, N. Y........	652	150	9	3	22	43	2	25	16	33
Fort Wayne, Ind....	1010	241	9	2	42	30	14	13	29	19
Peoria, Ill..........	131	26	7	3	5	11	1	1	5	1
South Bend, Ind....	143	46	6	3	6	6	5	6	7	5
Portland, Me.......	620	177	1	——	16	24	9	16	20	18
Charleston, S. C....	192	52	13	3	6	8	——	7	8	3
Rockford, Ill.......	181	45	11	3	5	15	3	5	3	9
Saginaw, Mich.....	120	48	3	——	——	7	2	3	8	5
Holyoke, Mass.....	287	79	5	2	15	13	5	2	5	15
Gary, Ind..........	281	78	10	4	5	11	3	13	6	12
Malden, Mass.......	187	56	3	——	3	9	——	5	3	13
McKeesport, Pa....	74	30	2	——	1	1	1	3	2	6
New Castle, Pa.....	74	31	3	1	3	2	——	5	2	12
Mt. Vernon, N. Y...	264	78	2	1	11	12	3	7	8	12
Evanston, Ill.......	287	81	9	4	7	17	2	7	6	11
Austin, Texas......	169	75	2	2	9	3	2	2	16	9
Muskogee, Okla....	42	20	2	——	——	3	1	1	2	9
East Cleveland, Ohio	109	35	6	4	1	1	1	6	6	7
TOTAL...........	31,475	9,534	821	298	1,095	1,429	495	740	1,046	1,200

* Winter refers to November, December and January. Summer refers to May, June, July.

Referring to the totals in the tabulation, and taking first the hours from 3 to 5 p.m. which are daylight in both summer and winter, the number of accidents are found to total 1429 in summer and 1095 in winter. The winter accidents from 3 to 5 p.m. are, therefore, 76.6% of the summer total. Considering next the totals for the period of 9 to 11 p.m. which is dark both in summer and winter, it is noted that the accidents are respectively 740 to 495. The winter accidents from 9 to 11 p.m. are, therefore, 66.9 per cent of the summer total. If these two percentages of 77.6 and 66.9 are averaged it is indicated that for the group of cities in this survey, traffic conditions are such that, excluding the influences of illumination, the winter accident rate in the afternoon and evening is approximately 71.8 per cent of the summer accident rate.

Considering next the period of 6 to 8 p.m. which in summer is daylight, there is shown a total of 1,200 accidents in the 32 cities during the three months of May, June and July. Hence, applying the average percentage of winter to summer accidents (71.8 per cent) determined as above it would be anticipated that in the three "winter" months of December, January and February, there would be 862 (71.8 per cent of 1200) accidents during the hours of 6 to 8 o'clock p.m. However, the survey shows a total of 1046 accidents to have actually occurred during these hours in the three "winter" months or 184 more than anticipated, provided there had been the same effectiveness of illumination in the "winter" months as in summer. Hence, there is the strongest evidence that 184 accidents or 17.6 per cent of all those at night must be attributed to the lack of light during the winter months. Applying this same percentage to the 9,534 accidents which occurred after dark in the 32 cities covered by this survey it appears that 1,678 would have been avoided if adequate illumination had been provided.

17.6 Per Cent of Night-Traffic Accidents Due to Inadequate Lighting

Assuming that the same proportion of day and night accidents which was found to exist in this survey holds in all cities, last year there must have been, out of the total of 10,640 killed, 3,223 deaths from night automobile accidents, and 17.6 per cent of these, or 567, were, therefore, directly attributable to lack of sufficient illumination. In addition to this loss of life a similar computation shows that the very substantial amount of $54,000,000 of the billion-dollar annual street-accident loss estimated by Dr. Crum may also be attributed to lack of light. According to census reports the total expenditure for street lighting in the United States is not in excess of $50,000,000.

The percentage of 17.6 arrived at as the proportion of night accidents which may be attributed to lack of light, is undoubtedly an extremely conservative figure to use in evaluating the usefulness of illumination in preventing traffic accidents, for, as a matter of fact, the streets of all of the cities covered in the foregoing survey were illuminated at night by artificial lighting of varying degrees of effectiveness. In an individual city where the need for better street lighting is especially evident, the percentage of night accidents chargeable to the lack of light is likely to run as high as 50 per cent. On the other hand, in the

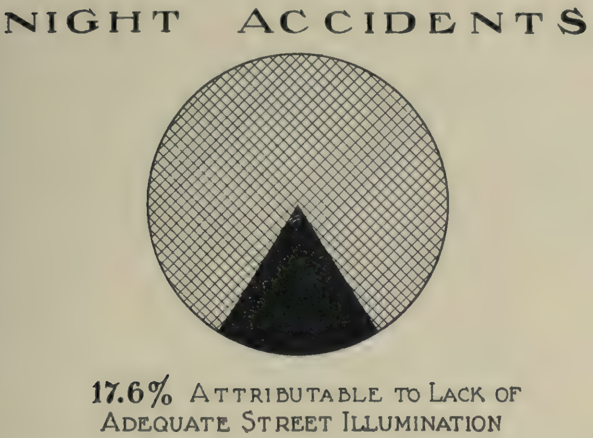

Fig. 4—*A Total of 17.6% of City Night-Traffic Accidents is Due to Inadequate Illumination*

case of those districts where fairly high levels of artificial street lighting are provided by so-called White-Way systems, the percentage of night accidents chargeable to lack of illumination can be said to be fairly low. It was hoped to have data from this survey to show the difference, but it was not found practical to separate the statistics for the better lighted sections in a sufficient number of cases to arrive at an average figure.

While in the present state of the art it is not practical to provide artificial street lighting approaching actual daylight levels, it is entirely feasible to increase the quantity of light to a level from 3 to 5 or even 10 times as high as that provided by average existing systems, and when this is done with properly installed equipment it may be confidently expected that a large measure of the benefit of light in reducing accidents will be obtained.

Responsibility for Accidents

That public appreciation of some of the functions of street lighting is increasing is illustrated by a recent incident in a suburb of San Francisco. A woman was accidentally killed by an automobile at a dark corner and in mentioning that the driver had been exonerated, the newspaper report states that the coroner's jury charged the Lighting Committee of the Board of Supervisors with the legal responsibility for the woman's death, basing its charge upon the circumstance that the location where the accident occurred was well known as a poorly lighted spot and that other juries had previously recommended that the Lighting Committee improve the illumination so as to eliminate the accident hazard.

In another recent case of this kind the plaintiff entered suit against a city and county in Ohio for many thousands of dollars for severe personal injuries in a street accident where the claim was based on the fact that the size of street lamp at the place where the accident occurred had been reduced from 300 to 100 watts. The plaintiff claimed that there was not sufficient illumination to reveal the road obstruction which was the immediate cause of the accident.

Influence of Street Lighting on Crime

So well understood is the preference of the evil doer for darkness that the unusual daring of the man who commits a "daylight" crime is featured in newspaper headlines while the same crime committed at night is noted in a paragraph as a commonplace. The recognized feeling of increased safety amid well lighted surroundings rests upon a more substantial foundation than simply an inherited dread of the danger of darkness; for the criminal makes his approach without warning when there are dark shadowy spaces, and his escape is made many times more sure when there are conveniently dark passageways and alleys in which detention is difficult.

The effectiveness of street lighting as a deterrent to crime is crystallized in the oft quoted statement attributed to a former Mayor of Chicago to the effect that "a street lamp is as good as a policeman." Unquestionably good street lighting multiplies the efficiency of the night police force. The most striking illustrations of the importance of lighting in preserving community safety come when by accident or otherwise all street lamps are out for a period of time. For example, in Chicago during the war an attempt was made to reduce coal consumption by

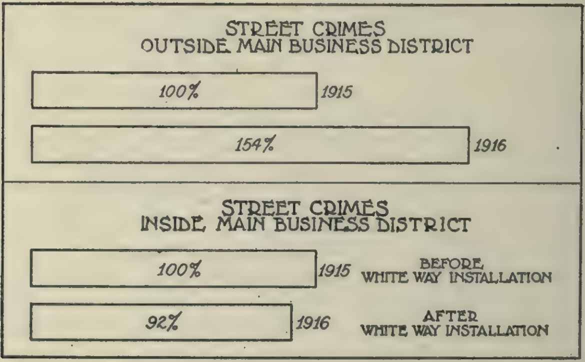

Fig. 5—*Survey Shows an 8% Reduction in Crime in District Lighted by High-Intensity White Way and During the Same Year Crimes Increased 54% in Remainder of City of Cleveland*

extinguishing the street lamps. The following newspaper headlines indicate the immediate result:

ELECTRICITY THE SILENT POLICEMAN

CHICAGO DARK; BANDITS BUSY

THIRTY-TWO HOLDUPS AND MANY OTHER CRIMES IN TWO-DAY PERIOD

MAYOR'S MOTOR STOLEN

STREET LIGHTING, TURNED OFF TO SAVE COAL, TURNED ON TO SAVE PEOPLE

Needless to say it was decided that the street lighting was necessary even in the face of a severe fuel shortage.

While the usefulness of better street lighting in reducing crime has been widely recognized there has been but little in the way of recorded statistics to measure its influence. However, the following quotation from a report of a crime survey in Cleveland by Harrison[4] bears out in a striking way the commonly accepted conclusions.

"Early in the year 1916 a high-intensity ornamental lighting system consisting of lanterns equipped with 1,000-candlepower and 1,500-candlepower incandescent lamps, spaced approximately 85 feet apart on each side of the street, was installed in the more important district of the business section of Cleveland. Altho the possible effect of the improved illumination in reducing crime was but a secondary consideration at the time of the installation, the widespread increase in the last few years in such crimes as assaults, holdups, and automobile thefts, has focused the attention on methods by which the crime situation could be remedied. It was with the thought of determining just what effect light had on the elimination of crime that a survey was made in Cleveland of the crimes committed both in the city as a whole and in the White-Way district. More than 1,000 cases of holdup, assault to rob, burglary (buildings entered from the front) automobile theft, pocket picking, etc., were included in this study of the Police Department records.

"It was found that 90% of these crimes took place after dark. Furthermore, before the new lighting was installed 17 out of every hundred of the crimes were committed in the small downtown area designated as the White-Way district, which embraced less than 1% of the street mileage of the city. Street crimes committed after dark during the months of October, November, and December of the year 1916, after the new lighting was installed, were compared with the corresponding months of the previous year, so that the possible effect of the increased lighting as a deterrent to crime might be determined. In this connection it will be recalled that 1916 saw the virtual beginning of a crime wave and that crime was increasing by leaps and bounds in all sections of the country. In Cleveland, in the areas outside of the White-Way district, street crimes committed after dark increased 54% over 1915; crimes in the White-Way district, however, actually decreased 8% in comparison with 1915. In other words, crimes in the business section of Cleveland in the year 1916 were only 60% of what might well have been expected had no change been made in the lighting."

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[4] Ward Harrison, Discussion of paper on Illumination and Traffic Accidents, I.E.S.Convention, 1921.

Good Street Lighting Contributes Greatly to Comfort and Convenience

While the fundamental or elementary service performed by street lighting is that of accident and crime prevention, it has an equally important part in contributing to the comfort and convenience of the community. A satisfactory street-lighting system not only makes possible the traversing of sidewalks and streets, but effectively reveals minor inequalities in sidewalks and paving surfaces and makes walking both safe and pleasant. Even in less frequented locations a printed or written address is readable without striking a match. Street signs are well enough lighted to be easily made out without the necessity of stopping to decipher them. House numbers are visible at a reasonable distance. Passing friends may be recognized on the streets in any part of the city. In the more congested areas a satisfactory level of illumination makes it possible to read newspapers or other matter while waiting anywhere on the sidewalk. The goal of a street-lighting plan, which is reasonably attainable without an undue expenditure, should be that the normal daylight activities on streets may proceed at night practically without delay or increased difficulty.

Commercial Advantages of Well Planned Lighting

The experience of dozens of communities has shown that proper street illumination is of advantage in providing favorable conditions for prosperity and progress in several ways. For one thing, there is a distinct gain in business efficiency from the extension of the hours of operation for which the safe and comfortable use of streets at night is a requisite. Further, light exercises a definite attraction for all people. How the illumination of a white-way street-lighting system changes a street which previously was practically deserted after sunset into a scene of activity and life thruout the evening hours is a familiar story. In specific instances where only one of two commercial streets was equipped with new lighting, the well lighted street has gained in the ratio of two to one or even three to one in evening traffic as compared with the poorly lighted street. The effect upon property values of such a concentration of business is obvious to all familiar with the way trade follows the crowd. Without considering the business interests of the merchants, well lighted business streets represent a real advantage to that very considerable number of the population engaged in work thruout the day and who, therefore, must do their shopping during the evening hours.

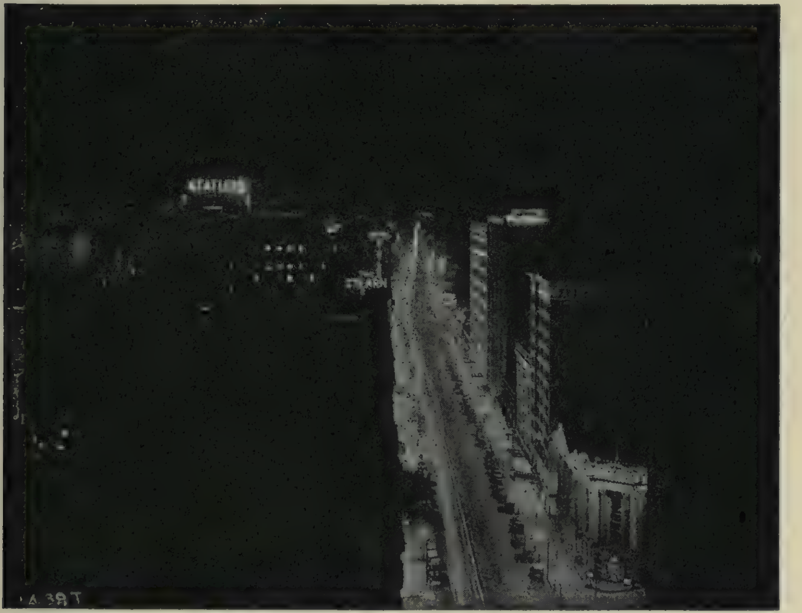


Fig. 6—*Euclid Avenue, Cleveland, Illuminated by 1,500-Candlepower Incandescent Lamps in Ornamental Lanterns Spaced 85 Ft. Apart*

Progressive real-estate promoters have realized the importance of good street lighting in adding to the attractiveness and value of property, and in developing new allotments. Therefore a liberal number of ornamental lamp posts are very commonly installed with underground current supply in place of the meager allowance of lighting equipment which is all the limited municipal appropriations will usually permit in outlying districts. This practice has not only been found to increase the sale value of the property, but has sometimes been found to have the additional advantage that it enabled showing the property at night to prospective buyers, some of whom were not able to arrange to come in the daytime.

Modern illuminating engineering has been of great assistance economically in making possible double-shift operation of industrial plants, thereby in many cases reducing the overhead charges on the investment in plant and machinery by as much as one-half. In the development of a level of street lighting such as will enable night traffic at the same density, speed, convenience, and safety as by day, there is offered a similar important opportunity for community economy. Large as the expenditures are already for improved thorofares and highways, engineers estimate that at the present rate of traffic growth duplicate roadways must be built very soon in many districts. This congestion, however, will be greatly relieved and the time when duplicate road construction is required will be postponed for years in many cases provided a larger proportion of the traffic can be diverted from the crowded day hours. In line with the economy of double-shift use of roads, Mr. Arthur Williams, of New York, recently presented a paper in which reductions as great as one-half in trucking cost were estimated to be possible by the increased utilization of equipment and terminal facilities and the avoidance of traffic delays by the use of streets during the less congested night hours.

Efficient Street Illumination

In considering a plan of street lighting for a city it is necessary to observe carefully the different requirements of each class of street to the end that the most efficient result possible may be obtained from the expenditure. It is obvious that the thorofares in the principal business district will require the greatest amount of illumination, for in this section there is congestion of foot, vehicle, and street-car traffic. The principal thorofares leading outward from the center of the city, and the streets in the wholesale and manufacturing districts likewise, carry much traffic of a high-speed nature and must be lighted accordingly. In the residential streets which do not carry thru traffic to any extent, requirements for illumination from the standpoint of traffic are, of course, much less severe. In certain outlying districts appropriation allowances sometimes make it necessary to reduce the lighting to a system of small marker lights for corners only.

It should be recognized, of course, that the highest intensity of illumination in the principal business streets of large cities at the present time is not greater than would be desirable for all streets of the city, except for the cost. However, because of the very great areas to be covered, and the limited appropriations available, it may be possible to provide, perhaps, only one-tenth as much light on residential side streets as in the principal business section. In consequence of these very low levels of illumination which must suffice for all except the limited white-way district, it becomes especially necessary to exercise the greatest care to see that the available illumination is so placed and directed that it contributes most effectively toward safety from crime and accident, toward the comfort and convenience of those using the streets, and toward improving the day and night appearance of the street.

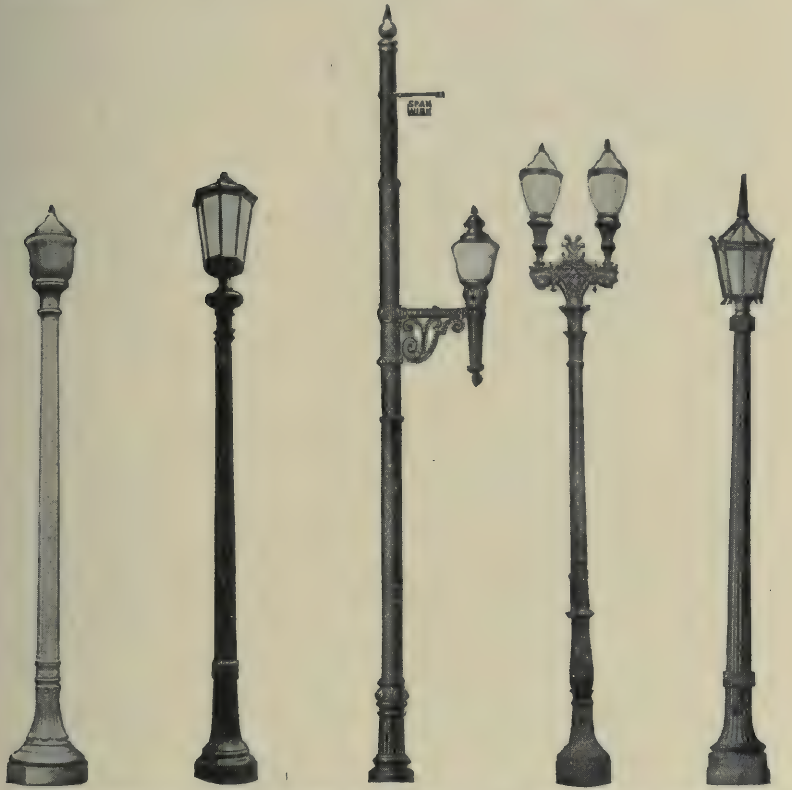


Fig. 7—*Typical Ornamental Lamp Equipments. These Designs Accommodate 600 to 2,500-Candlepower Lamps for Business Streets. Equipment of the Same General Character but Designed for Smaller Lamps is Used for Ornamental Boulevard or Residence Street Lighting*

Not only are there differences in local conditions to be considered in planning street lighting, but also the developments in the power of lamps and in the efficiency of equipment have been so rapid that there are not as yet fully definite standards of design which are generally adhered to for the different classes of streets. However, there are certain tendencies which have come about as a result of experience with different types of installations under various conditions. Table II contains a summary of practice as to lamp size, mounting height, and spacing applicable to the different classes of streets.

Table No. II. Summary of Street Lighting Practice

Street Class	*Size of Lamps*	*Mounting Height*	*Spacing*
Business district	600, 1,000, 1,500, and 2,500 c.p.	14–18 ft.	80–125 ft.
Boulevards & parks	250, 400, 600, and 1,000 c.p.	14–20 ft.	80–200 ft.
Wholesale & mfg. districts, and thorofares	400, 600, 1,000, and 1,500 c.p.	20–25 ft.	150–300 ft.
Residential..........	250, 400, and 600 c.p.	14–20 ft.	150–300 ft.
Outlying districts and alleys	100 and 250 c.p.	14–20 ft.	150–300 ft.
Highways	250 and 400 c.p.	25–35 ft.	300–600 ft.

The lower mounting heights should be adopted only with the smaller lamps and at the closer range of spacings. For the larger lamps and the wider spacings the upper range of mounting heights is preferable.

Principal Business Streets

For important business streets in cities, the most widely favored method of lighting consists in the use of single-light ornamental standards mounted at heights from 14 to 18 feet and spaced opposite each other at distances of 80 to 120 feet. For very narrow streets the lamps may be placed on one side only or staggered at the same spacing. An important increase in efficiency is secured by the use of lamps of 600, 1,000, 1,500, or 2,500 candlepower instead of the 3, 4, or 5-light clusters using small lamps which were the vogue before the introduction of the high-powered gas-filled incandescent lamp. Typical equipments of modern character are shown in Fig. 7. There is at present a very noticeable tendency to depart from the use of the opal ball or globe, and to use instead a lantern structure, which by many is considered more pleasing in appearance. Cleveland was the first large city to adopt equipment of this character and has something over 1,500 standards of the type illustrated in the second illustration from the left in Fig. 7, using 1,000 and 1,500-candlepower incandescent lamps. These lanterns are glazed with a rippled glass and are used with prismatic refractors which increase the amount of light delivered to the street by turning downward the light rays which in an ordinary opal globe are largely lost.

Instead of the single-lamp standards spaced relatively close together, some cities have adopted standards carrying two or even three high-power lamps mounted 20 to 30 ft. above the street and spaced 150 to 200 ft. apart. The resultant effective illumination is not greatly different from the more usual arrangement and the exceptionally high mountings minimize any possibility of glare from the lamps. On the other hand, there appears to be much weight on the side of those who contend that on business streets the surrounding brightness of buildings, show windows, etc. is such that there is no possibility of serious glare, even with the large lamp at the lower mounting of 15 to 18 ft., and that the desirable white-way effect is enhanced by lanterns at these heights spaced 80 or 90 ft. apart.

The demand for higher levels of illumination on business streets has led in some cities to the consideration of lamp standards carrying two or three 1,000 or 1,500-candlepower lamps each and spaced no more widely than previous single-lamp installations. It is quite possible that there will be an increased development of this tendency, especially in the larger cities where the crowds from evening business and amusements have become such that in many cities white-way systems which were installed quite largely as an ornamental or advertising feature are even now barely adequate from the standpoint of lighting for safety.

Thorofares

The thorofares leading out from the business section and the streets in the wholesale and manufacturing districts have developed severe requirements for lighting under the new conditions of transportation. These streets carry high-speed traffic and are the location of a large percentage of street accidents, particularly at night in those cases where a proper provision for lighting has not yet been made. In some instances it is found practical to extend the high-intensity lighting of the business district to include these streets. However, this usually involves a greater expenditure than is permissible, and in any event the light colored building surroundings characteristic of the business section are lacking in most of these thorofares and for this reason as well as because of the wider spacing, it is desirable to use a greater mounting height for the lamps in order to avoid the blinding effect of glare. A fair provision for thorofares outside the business district is an arrangement of lamps of 600, 1,000, or 1,500-candlepower spaced from 150 to 250 ft. apart, or, at a maximum, 300 ft. If the street is very wide it may be necessary to consider each side as a separate street and provide lighting accordingly. The mounting height should be 20 or preferably 25 ft., in order to remove the bright light sources farther from the line of vision, and also in order to obtain a better spread of illumination. In the past, especially where there were wooden pole lines on the streets, it has been common practice to use a lighting fixture such as illustrated in Fig. 8 suspended from a mast arm. The mast arm has the virtue of bringing the lamp out over the street surface, thereby causing the light rays to clear low hanging foliage of adjacent trees. Bringing the lamp over the pavement also increases the possibilities of seeing objects by silhouette against the bright spot of light beneath the lamp or against the bright streak or glint reflections from the pavement. This is an especial advantage in the case of much traveled streets, which soon become blackened from oil but are polished by wear and have a glossy surface when wet. Under these conditions, a very large dependence must be placed upon seeing objects in silhouette against the glint from the pavement on account of the low level of general illumination.

The fixture in Fig. 8 is equipped with a prismatic refractor and this feature is usually incorporated in the equipment for this type of lighting, since, by means of the refractor, the candlepower of the lamp at angles directed to the zone midway between lamps may be increased practically 100%. Therefore, the light delivered on the street is much greater than with equipment which does not take full advantage of the upward rays from the lamp filament.

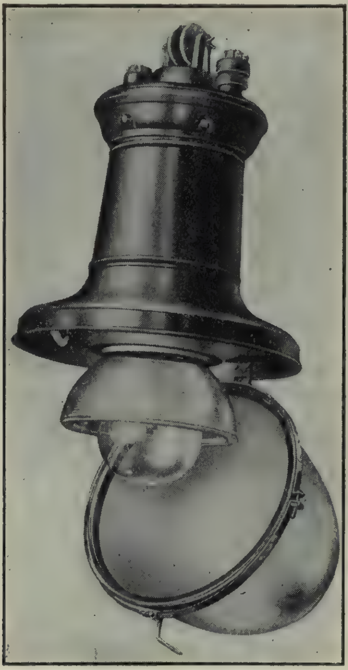


Fig. 8—*Pendant Refractor Fixture for Mast-Arm Suspension*

Recent designs of lighting equipment for thorofares and boulevards have shown the results of efforts to retain the efficiency of light distribution of the mast-arm-pendant refractor-unit type of lighting, and, at the same time, to obtain a construction which would add to the appearance of the street. Some of these bracket-type lighting standards for thorofares or boulevards are illustrated in Fig. 9.

Residence Streets

Where residence streets carry a large amount of thru traffic they are in effect thorofares and should be lighted as such. However, in every city there is a large percentage of street mileage not used for thru travel and, therefore, not subject to a large amount of high-speed traffic. Even in these streets, however, sufficient illumination must be provided to enable discernment of objects and obstructions in the pavement by one traveling at a moderate rate of speed. Illumination for sidewalks must also be provided which is adequate for comfortable walking and which does not leave such dark shadows behind tree trunks as might serve as possible hiding places for footpads.

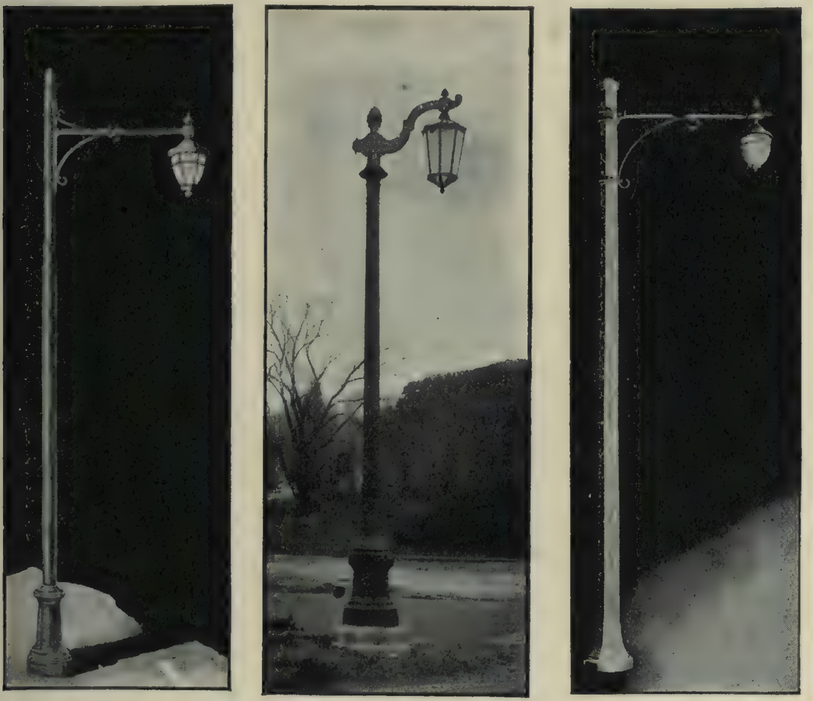
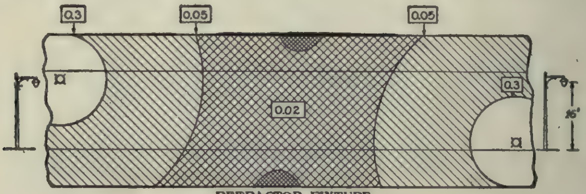
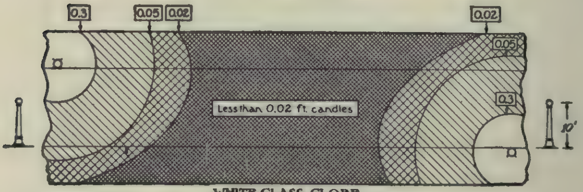


Fig. 9—*Ornamental Bracket Standards for Lighting Thorofares and Boulevards. In These the Height to the Lamp is Approximately 20 Ft. Similar Designs for Smaller Lamps are Made with Heights of About 16 Ft. for Residence Streets*

Residence streets are very commonly well provided with trees; hence, unless the lamp is suspended over the center of the street, it is often necessary, in order to avoid a large loss of light, to use somewhat lower mounting heights than would be desirable on streets without trees. However, in view of the lower candlepower of the lamps commonly used (250 candlepower), they may be placed as low as 15 ft. above the street without undue glare, provided the light is properly diffused and directed. When larger lamps are used and at wider spacings, heights of 18 or 20 ft. are considered preferable practice. In this matter of adequate height the ordinary wood-pole bracket installations have been better than many systems of ornamental standards supplied from underground wiring. Some of these systems have used globes mounted on upright posts only 10 or 11 ft. in height and while tree foliage is successfully avoided the units are likely to prove very glaring in the eyes of drivers, pedestrians, or of people on porches. Furthermore, a very close spacing must be adopted if all sections of the street are to be illuminated. Particularly on a curved road, glare from lamps placed too low may so interfere with vision that the lamps may actually become a source of danger to automobile drivers. In view of this, in recently designed systems there has been a tendency to adopt a minimum height of 15 ft. for ornamental posts on residence streets. Also, ornamental bracket designs have been developed bringing the lamp 16 ft. or more above the street and with a bracket length of 4 or 5 ft. to assist in clearing the foliage. When these equipments carry well designed refractor fixtures the light utilization is as great as from the efficient but often unsightly wood-pole brackets.



REFRACTOR FIXTURE



WHITE GLASS GLOBE

Fig. 10—*Illumination from 250-Candlepower Lamps Computed for Residence Streets. Top: Refractor Lantern Bracket 16 Ft. Above Street. Bottom: Opal Globe on 10 Ft. Post*

Fig. 10 illustrates the remarkable increase in effectiveness from equipment of this character compared with a system of low-mounted upright ball globes.

Lamp spacings on residence streets vary greatly. Where overhead wood-pole distribution is used and the appropriation allowance is very limited, spacings of the order of 300 ft. may be used to give fair lighting provided there are no trees to obstruct the spread of light. On the other hand, spacings of 100 ft. or even less are not uncommon for underground distribution supplying low-mounted ornamental units. Unless the interference from trees is excessive, spacings of 150 to 200 ft. are found satisfactory. The lamps are customarily staggered to reduce tree-trunk shadows.

Outlying Districts and Alleys

Figure 11 illustrates a typical bracket, with a radial-wave reflector suitable for attachment to wooden poles or buildings in outlying districts or alleys. This equipment using the 100-candlepower lamp and mounted 15 to 20 ft. above the streets forms a very inexpensive type of equipment for those locations where small lamps are all that can be provided and where, consequently, a wide spread of light and the matter of the best protection against glare is of less importance.

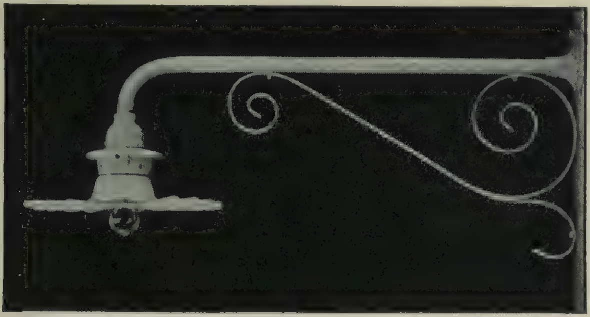


Fig. 11—*Radial-Wave Reflector and Bracket for Small Lamps*

Highways

Where it is desired to illuminate only the roadway without particular regard for the surroundings, special types of equipment such as that illustrated in Fig. 12 are suitable. This so called highway lighting unit is made up of nested parabolic construction so as to direct a high intensity up and down the road with very little side lighting. If mounted high, say 25 to

35 feet, and spaced from 300 to 600 feet apart with 250 or 400-candlepower lamps, equipment of this kind provides an illumination which is of very great assistance to night drivers in avoiding accidents.

Proper Maintenance is of Prime Importance

In view of the facts that the quantity of light provided by existing street lighting systems is at best barely adequate, and also, that in general the lamps are so widely spaced that in case one lamp is out a considerable section is left practically in darkness, it is especially important that careful attention be given to cleaning and maintaining street lamps. Cases are not infrequent where even with well designed equipment less than one-half the expected illumination is being delivered simply because the lamps and equipment have been allowed to accumulate dirt, and lamps which have lived beyond their useful life have not been replaced. It is true that the widespread adoption of incandescent lamps has greatly simplified the problem. There are no fumes to cause permanent depreciation of reflectors or glassware, and since air draft is entirely unnecessary fixtures and lanterns can be made fairly dust-proof and easily cleanable. In most cases, therefore, all that is required to avoid an expensive waste of light is a cleaning of the lighting equipment at regular intervals of approximately one month (oftener in very dirty locations and less often in exceptionally clean places), and a prompt renewal of burned-out or obviously defective lamp bulbs.

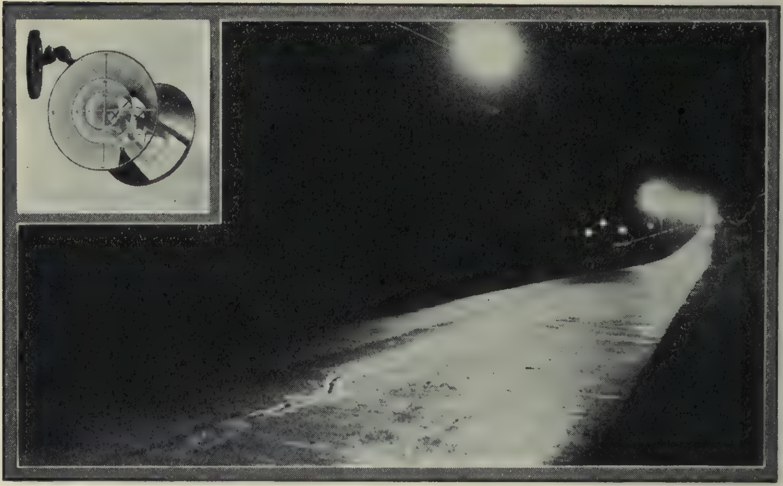


Fig. 12—*Special Lighting Equipment for Highways*

Cost of Adequate Street Lighting

A recent survey showed that 15 years ago approximately 5.4 cents out of each dollar of municipal taxes was the average amount expended for street lighting in cities of 30,000 population or larger in the United States. In the face of the need for much better lighting the amount allotted to street lighting for the same cities in 1919 had fallen to an average of 3.8 cents. In an article commenting upon the comparatively small expenditure for this essential public service, Mr. A. F. Dickerson reported that the average per capita expenditure in cities is only about $0.70 annually for street lighting. The highest found was $4.81 per capita, and in 50 of the best illuminated cities there was an average of $2.04 per capita.

It is probably not sufficient to compare street-lighting expenditures on the basis of population alone, since in cities having the same population there may be a considerable difference in the number of miles of improved streets. Possibly a fairer method of comparing street-lighting appropriations is to base the computation on the length of paved streets. Even on this basis there are many variables which should have weight. Some of these are the layout of the city, the width of streets and arrangement of intersections, the amount of tree foliage, the character of street paving, whether current is distributed overhead or underground, and the local cost of labor and materials entering into construction. However, the following tabulation indicates the order of annual cost per running foot of street.

Class of Streets	*Annual Cost per Foot of Street*
Business district	$1.00 to $4.00
Thorofares, mfg. districts, blvds.	.25 to 1.00
Residential streets	.15 to .60
Outlying districts and alleys	.05 to .20

The lower range of figures applies to systems involving a minimum outlay for installation and in general providing minimum levels of illumination. The upper range of expenditure in most cases permits an adequate installation consisting of underground distribution supplying ornamental lamp-standards of substantial design and properly spaced to obtain maximum effectiveness of illumination.

The initial investment for installation of circuits and equipment is a factor which affects the design of street lighting in a greater measure than it does interior lighting. Especially where the service to the lamp is carried underground, as is becoming more and more the practice for new installations in progressive cities, the fixed charges on the investment for equipment may actually form half the total annual cost of the system. However, the cost of installing duct and cables, the cost of the lighting standard and fixture, and some of the costs of maintenance, such as cleaning and repair to equipment, increase but little for the larger sizes of lamps as compared with smaller. There is consequently a distinct economy in cost per unit of light by adopting the larger lamp sizes. For example, in the case of a series underground supply to an ornamental lighting system, the annual cost of a 1000-candlepower lamp is only of the order of twice that of a 250-candlepower lamp, even tho the larger lamp supplies four times as much light.

In view of the insufficiency of municipal appropriations it became quite common several years ago for individual groups of property holders to install sections of improved street lighting with ornamental equipment, at private expense. However, because of the difficulty of insuring a continuance of proper maintenance under this plan, and also because of the recognition of the importance of this lighting as a municipal improvement, present practice is very distinctly in the direction of having the city handle contracts for the installation and operation of all street lighting. Particularly in business districts the city may assume the entire cost of the system in view of the benefits accruing to the city as a whole. In other cases a large part of the cost of special lighting may be charged back to abutting property under the laws in many states which permit the establishment of special improvement districts in which assessments are made for the street lighting in the same manner as for the paving and other necessary street improvements.

DISCUSSION

A MEMBER: Is not suspending lights on trolley poles poor economy because of broken filaments?

MR. ANDERSON: There are a number of systems in operation where street-lighting units mounted directly on the trolley poles have proven satisfactory. In the high-power incandescent lamps now used the filament is thicker, and thus the lamps are better able to withstand vibration.

A MEMBER: How many hours will one of those lights burn?

MR. ANDERSON: The street series lamps have a rated average life of 1,350 hours.

A MEMBER: How does the incandescent compare with the arc light as far as efficiency is concerned?

MR. ANDERSON: In arriving at a comparison as to the true efficiency of the two illuminants it is necessary to take into consideration such items as station capacity required, efficiency and cost of auxiliary equipment, amount and distribution of light on the street, lamp-candlepower maintenance, and the cost of keeping the system in good operating condition. The only arc lamp which is in common use at the present time is the magnetite arc. The 400-candlepower incandescent lamp when equipped with a rippled globe fixture employing a refractor is considered to give an amount of light on the street at least equal to the 310-watt arc lamp with standard equipment. The 400-candlepower 15-ampere lamp including the loss in the individual transformer consumes only about 240 watts. The central station in one of the largest cities in the United States has found it profitable to replace gradually all of their magnetite arc lamps with 400-candlepower incandescents.

A MEMBER: This lamp that gives the more even distribution of light—what is the principle on which that is made?

MR. ANDERSON: The principle of light refraction by glass prisms is the basis for the design of this type of equipment. The lamp is fitted with a prismatic glass refractor which directs the light rays, which otherwise would fall in the upper hemisphere, into the zone from 10° to 20° below the horizontal, where they are most needed. The lamp and refractor are inclosed in a globe of rippled or stippled glass which reduces the intrinsic brilliancy and increases the apparent area of the light source. The globe also breaks up the light rays and gives to the unit a lively and very pleasing appearance.

NEW DEVELOPMENTS IN STREET LIGHTING

By C. A. B. Halvorson, Jr., & R. B. Hussey, Street-Lighting Engineering Department, General Electric Company, West Lynn, Mass.

About ten years ago a definite movement was started in this country for higher class street lighting with particular reference to the business centers of the cities. There were developed for the purpose several lighting units embodying good artistic design, high illuminating efficiency, together with reasonable cost both of installation and maintenance. This city of Baltimore was one of the very first cities in the country to instal one of these ornamental type intensive lighting systems.

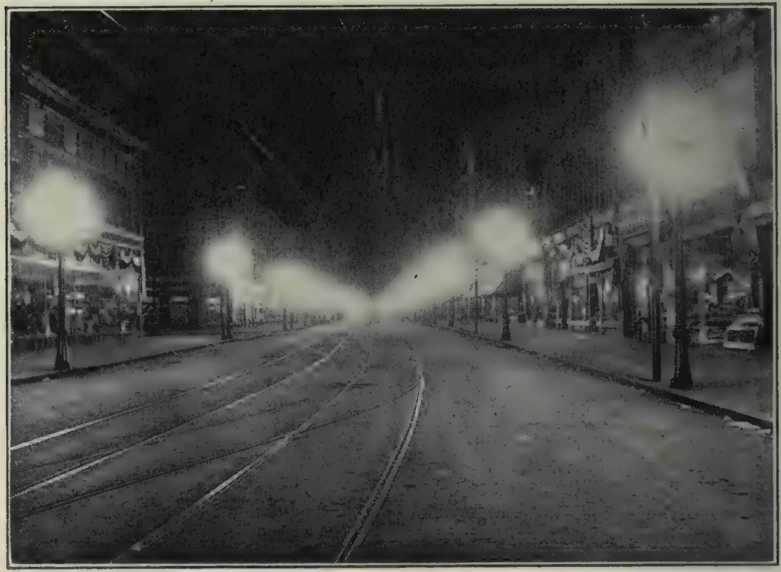


Fig. 1. A Well-Lighted Business Street

It is not necessary to more than call attention to the remarkable success of this type of lighting. It was new and attractive and made a direct appeal to every citizen. The retail merchants saw in it an advertisement and in other ways a distinct asset to their business. The central station welcomed the new system as a steady source of revenue and as a stimulus to domestic lighting. To the citizens as a whole the intensive illumination of the business district became a civic improvement of which they could justly be proud. So it is not strange that this type of illumination, white-way lighting as it has been called, spread and was adopted in practically every city in the United States and neighboring countries as well. The standard of illumination in this intensive lighting campaign was set at a high level. Many thought it was too high, but the results have amply proved the wisdom of advocating the high values that were chosen and employed for this class of lighting. So much attention has been given to this class of street lighting that at the present time all the large cities and most of the middle sized municipalities are equipped with some form of ornamental lighting units which produce a high intensity of illumination without glare thruout the more important business districts. More recent developments in the application of these high-intensity units of light, especially in the West, are of interest as indicating how futile were our early fears for the success of the white-way movement. Now installations can be found where single standards bear two, three and even five ornamental luminous-arc lamps of highest illuminating power spaced from 75 to 100 ft. apart. This has been followed by the systematic development of the lighting of the other sections of the cities where the required intensity of illumination is necessarily

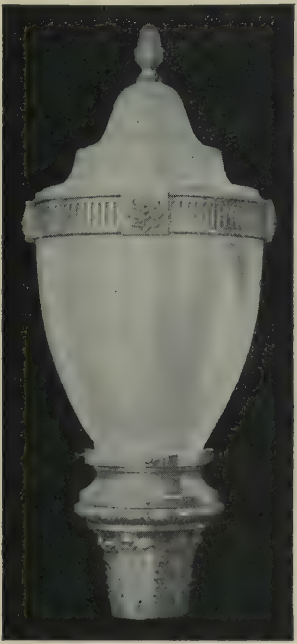


Fig. 2. Lamp-Fixture, Saratoga, N. Y.

lower. In these secondary zones or areas the appearance of the units, the character of the light and the freedom from glare are matters that have to be taken into consideration and the particular type of distribution must be studied with even more care, as the light from each unit must be more definitely placed in order to accomplish the best results.

No one today questions the value or importance of well lighted cities, so thoroly has this phase of lighting been discussed. After becoming accustomed to the illumination and appearance of one of these streets, to return to the comparatively low intensities formerly prevalent would be a marked retrogression, and hardly anything in civic affairs would create a greater amount of dissatisfaction among the citizens.

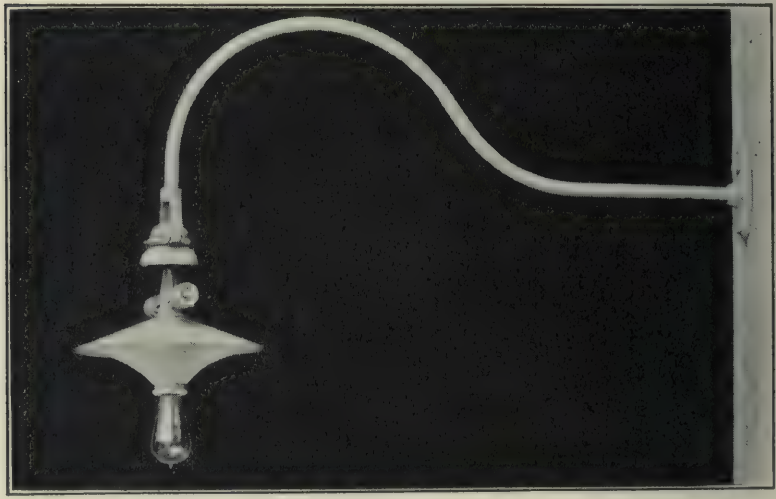


Fig. 3. Early Type of Street-Lighting Unit

There are but two distinct types of illuminants in general use for high-grade street lighting thruout this country, the magnetite or luminous-arc lamp and the Mazda lamp. In a large number of important cities the arc lamp is used for the illumination of the down-town business districts while the Mazda lamp is used in the residence streets and other lower-intensity sections, parks and the like. Frequently, however, in metropolitan centers each type of lamp is found thruout all the streets. Existing installations constantly are being modified and re-arranged along these lines and new installations are being made from time to time taking account of the particular merits of each type of illuminant.

During the last year or two there have been a number of improvements and new developments in the matter of illuminating glassware. Older kinds of globes frequently showed a good appearance but only at a considerable loss of light. The newer types, however, in many cases will produce effects that are superior to any that could be formerly obtained and at a much higher efficiency. The so-called "rippled glass" is a notable example of such material. This is a clear crystal having a fine rib or ripple in a general vertical direction which serves to spread the light laterally and reduce the apparent intrinsic brilliancy with the smallest possible absorption loss. At the same time a "snap" or "sparkle" is produced that makes the unit more attractive. Such glassware is now available for different kinds of lamps and for all sizes and equipments. Along the lines of obtaining the greatest efficiency of light together with economy of electricity, attention may be drawn to the double-service fixtures in use in Saratoga, New York. (Fig. 2.) The large diffusing globe shown on this view contains two lamps. The larger, of 1,000 c.p., is intended for service up to midnight and the smaller one, of 100 c.p., is intended for service from midnight until dawn. A simple switching device is installed in it so that the change from one lamp to the other may be made from the central station whenever desired.

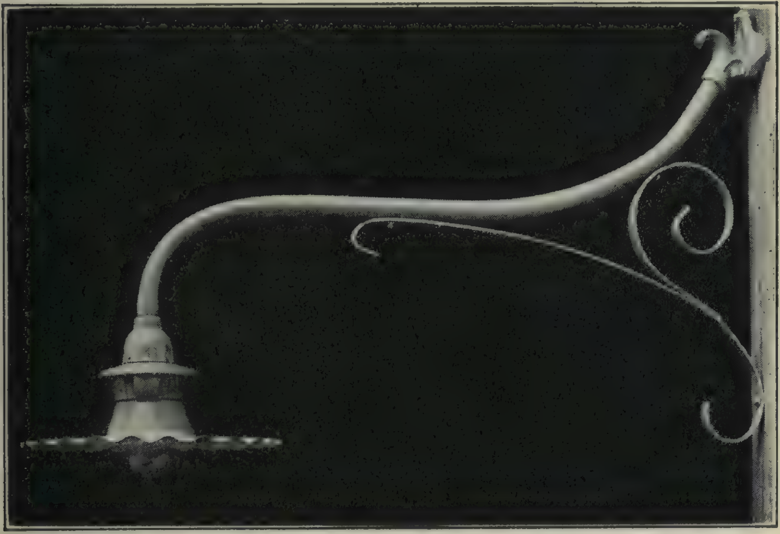


Fig. 4. Radial-Wave Reflector Unit

There is, however, another phase of street lighting that has been somewhat neglected, altho it is of great importance and is constantly increasing in its demand upon the public attention. This is the adequate illumination of the highways and main interurban roads. This problem is an entirely different one from the illumination of the downtown business sections and residential districts. The distances to be covered are great and on account of expense it is not possible to use more than a minimum of energy. On the other hand it is not necessary to pay as much attention to the artistic design of the unit or in many cases to insist upon the entire concealment of the wiring. There are few buildings to be lighted and in fact in some cases the light thrown out to the area outside the roadway may be an actual detriment. The lighting of our highways has long been recognized as a field for further development and an active campaign of publicity is making for the safety and betterment of a very large class.

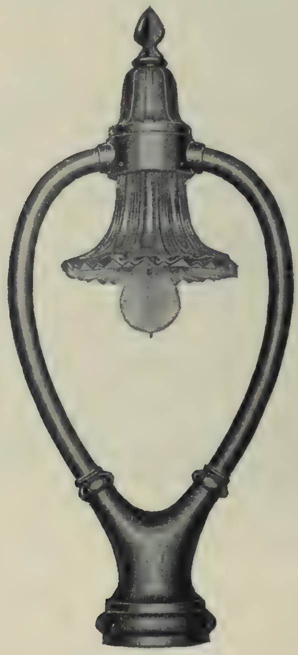


Fig. 5. Norvalux Fixture as Used at Rochester, N. Y.

To meet the requirements of this field of lighting several types of units have been developed and used on the streets and highways thruout the country.

In point of time the first electric lighting unit that was used in any great numbers for such lighting was the one shown in Fig. 3. This consists, as may be seen, of a curved iron pipe attached to a pole and carrying a small lamp and a conical shaped white reflector or "deflector" as it is now called. This deflector is parabolic in shape and so designed that, insofar as the direct or specular reflection is concerned, the incident light is reflected at a small angle below the horizontal. The reflected light is thus put where it is most needed but, as can be easily seen from the photograph, only a very small amount of light reaches the reflector and much escapes above the horizontal, where it serves no useful purpose.

Having these defects in mind another type of reflector was evolved and is shown in fig. 4. This is flatter and subtends a much greater amount of light than the former type. The radially placed ribs or corrugations in the reflector serve several purposes. They make a much stronger reflector mechanically, afford a distinctive and not unpleasant appearance, and the arrangement is such that it tends to throw the reflected light closer to the horizontal than would be the case with a flat smooth reflector. These reflectors have been made in a number of sizes and forms and used all over the United States. Several forms of mounting also are made to meet varying conditions. One of the latest developments of this type of unit has been to combine in a single piece the porcelain insulator necessary for use on series circuit with the reflector, the same piece of porcelain serving as insulator, casing and reflector all at the same time. This provides a unit of ornamental character with high efficiency where the light is to be distributed symmetrically around the source. This and other types of highway lighting fixtures have been used in many places with very satisfactory results. Rochester, N. Y., has a notable installation of fixtures of this design.

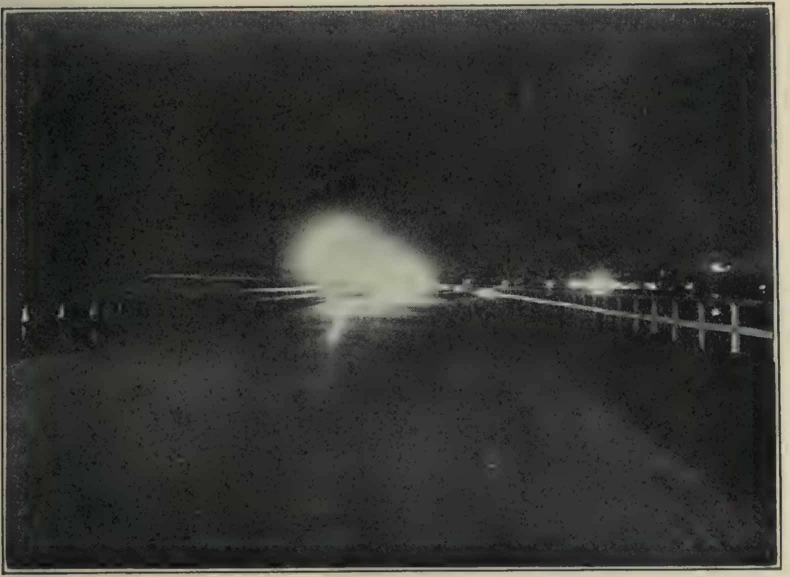


Fig. 6. Specular Reflection on Street Surface

In many cases, except perhaps where lamps of less than 100 nominal candlepower are considered, it is desirable to use some form of diffusing globe of opalescent or rippled glass to decrease the brilliancy of the light source.

A point not often realized is that the choice of lighting equipment should be governed to a considerable extent by the character of the road surface. If the road is smooth and well oiled so that there is a high degree of specular reflection or shine from the surface then a prismatic refractor or similar device will be productive of good results, but if a road with dull surface, rough or sandy, is encountered, the most suitable equipment will be a diffusing globe. This shine or reflection from the surface is of great importance. It enables objects on the highway to be perceived much more readily and at greater distances, than under other conditions. Fig. 6 shows this reflection along a well lighted street.

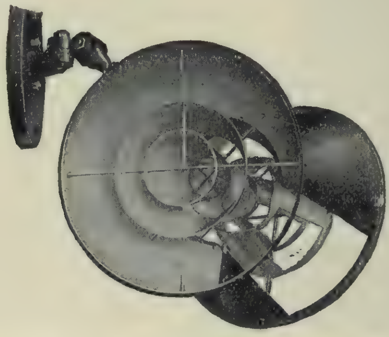


Fig. 7. Highway Lighting Fixture

One great advantage of these high-brightness surfaces, which are mirror-like in action, is that the actual light flux need not be high. In other words, the direction of the light, the angle of incidence and the production of silhouette effects are more important than mere volume of light.

The illuminating efficiency on ordinary highways is nevertheless low since in such cases it is desired to illuminate only the roadway and this of course subtends but a small proportion of the total solid angle from the lamp, so that from the point of view of the proportion of light flux generated such units are not extremely economical. With the demand for better illumination on the highways and the ever present limitations on the amount of money available for illumination, there has been an increasing demand for some unit that will conserve the light to a greater degree and confine it more closely to the road instead of spreading it into the fields and along the sides of the road. If some way could be had of redirecting the light so that as much as possible would reach the roadway, a much more satisfactory unit would be obtained. In other words it is essential to make better use of the light generated in the lamp. In order to accomplish this purpose a new type of reflector and equipment has been developed and just recently put on the market.

This is known as the highway lighting unit and is illustrated in Fig. 7. This consists of a series of nested or concentric parabolic reflectors made of steel and coated with white porcelain enamel. These reflectors are so arranged that the light is directed up and down the highway and as much as possible of it confined to the road surface. They are best placed at a height of from 30 to 40 feet above the ground and lightly tilted so that the center line of the beam strikes the middle of the roadway. Figures 8 and 9 show a portion of the highway between Swampscott and Salem, Mass., where these units are now used with very satisfactory results. In this case lamps of 2500-lumens (nominal 250-c.p.) rating are used, altho other sizes of lamps may be put into the fixture.

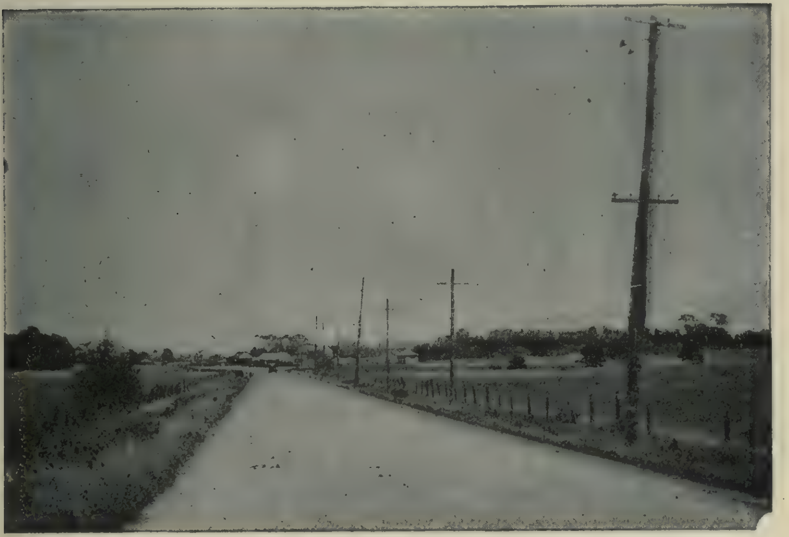


Fig. 8. Highway Between Swampscott and Salem, Mass. Day view showing Highway Lighting Installation

Satisfactory illumination can be obtained with these units at spacings of 500 to 600 feet under ordinary conditions, using the

2500-lumen lamp (250-c.p.). With this unit full advantage of the specularity of the road surface can be taken. The glaring effect is reduced, due to the large apparent size of the light source, i.e., reflector, the height of the unit and the reflection from the street surface.

Where the conditions are different, as at corners where light in four directions is necessary, this same type can be made with four sets of concentric reflector elements at right angles to each other instead of two sets opposite as shown in the illustration, or a type of fixture may be used giving light all around, in which by the use of suitable reflector or refractor the upward light is redirected down to more useful angles. Such equipments are available for suspension over the street from cables or for mounting on poles and for different sizes of lamps.

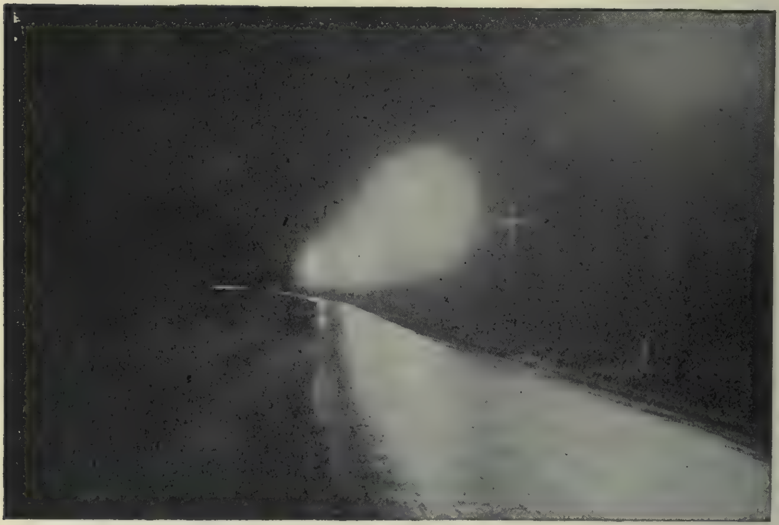


Fig. 9. Highway Between Swampscott and Salem, Mass. Night View, Showing Illumination from Highway Lighting Fixtures

The highway unit above described is suitable for lighting highways of all types where it is desired to light only the road surface and where it is either undesirable or unnecessary to put any light outside of the limits of the road and the gutters. Since automobile traffic is everywhere increasing so fast it becomes particularly important to illuminate the highways to a high degree for safety. This fact is generally admitted and is equally true for the city streets, boulevards and highways, so that in addition to making the streets more pleasant for traveling it is a distinct value to the State in that it is a preventive of accidents.

It may not be a too distant view into the future to imagine adequate highway lighting the solution of the automobile headlight problem which is now taking the attention of scientists, engineers and municipal and state authorities thruout the country. If the highways, interurban roads and residence streets were sufficiently well lighted so that headlamps could be dimmed, there would be no trouble encountered from glare and accidents due to this cause would be eliminated. Under such conditions the bright headlamp would need to be used only on side streets, alley ways and the like. The initial expense for properly regulating headlamps and the maintenance of them both in regard to attention, lamp renewal and power consumed would, considered as a whole, make quite an item toward the maintenance of suitable highway lighting fixtures along the principal roadways thruout the country. The energy consumed in the headlamp on an average automobile when multiplied by the number of cars in use would show a large amount of electrical energy generated and stored at comparatively low efficiency and used at present for spot lighting the roadway and throwing oftentimes a dazzling glare into the eyes of other drivers and pedestrians. An interesting thought in this connection is that one of our most thickly settled states has recently enforced a headlight law which required the automobile owners of the State to spend approximately $2,000,000 for devices to modify the normal light distribution of their headlamps in order to comply with the law. This sum would have covered the initial cost of installing adequate highway lighting of some such type as described above on 1,000 miles of highway and as there are but 1,400 miles of State highway all told it is safe to say that with much of the highways already lighted the problem in this particular State might have been solved for all time in a logical and rational manner. A slight additional amount per registration would cover the $200 per mile per year of maintenance. We do not wish it to be understood that we are not in sympathy with the efforts of various state authorities to mitigate the glare nuisance but on the contrary are heartily in sympathy with this movement but we believe that the problem of auto glare *per se* should be taken care of at the source, viz., by the automobile manufacturers, and not left to the public at large to contend with. One great advantage of the plan suggested would be that in its entirety and in its details it would be worked out by men of large engineering experience rather than by the users of automobiles who lack such specialized knowledge.

DISCUSSION

A MEMBER: If you had lights that would produce in one light what you got in three, would you consider it better or equal illumination?

MR. HUSSEY: From the point of view of actual light delivered on the street surface a single lamp will do better than the same intensity divided among several lamps. There is, however, another point. If one of these globes were to be used and a lamp of three times the intensity placed in it the apparent brightness of the globe or its intrinsic brilliancy would necessarily be three times as great and would be so high as to cause a dazzling or glaring effect. With the present globes and lamps the intrinsic brilliancy is about as high as can be used without discomfort.

A MEMBER: Why were those lights put up so high?

MR. HUSSEY: On account of the high intensity of illumination. These three-lamp standards are the type used in San Francisco where a very large quantity of light is used for the street lighting. With single lamps at spacings of about 75 feet on each side a better effect would probably be obtained with the lamps placed lower down, but with 3 or 5 lamps on each pole as used there the volume of light is sufficiently great so that the units can be raised considerably higher and a more even and pleasing effect produced.

ORNAMENTAL STREET LIGHTING

By L. A. S. Wood, Mgr., Illuminating Section, Westinghouse Electric & Mfg. Company, George Cutter Works, South Bend, Indiana.

The lighting of our streets at night is a vital municipal issue and adequate illumination, besides being a convenience, is, in addition, a protective necessity to every community. Good lighting is an indication of prosperity and an investment in a well designed ornamental street-lighting system returns large dividends to the tax payers in advanced real estate values.

Good street lighting creates a psychological impression of thrift and progress, advancing civic pride, attracting favorable publicity and promoting other improvements. It assists the fire and police departments, facilitates congested traffic and decreases crime.

In the early days of electricity, street lighting design was a simple problem, the solution of which generally took the form of suspended arc lamps at street intersections. With the growth of the "City Beautiful" idea, however, and the demand for lighting systems of a more ornamental character which will eliminate unsightly overhead equipment, many factors not provided for in the earlier systems have to be considered. The more important of these are the size of the city, the character of the buildings, the presence of foliage on the streets and the local conditions controlling the distribution of electricity.

Standard of Illumination

The standard of illumination on our streets was set by the earlier types of open carbon arc lamps which were later replaced by an improved type having longer burning hours, known as the enclosed carbon arc lamp. This latter was not so efficient as the open arc and its substitution in place of the earlier type tended to decrease the standard of illumination and it was generally lower than was customary in the larger cities of Europe. It will often be found that the energy consumed in lighting a comparatively small room in a public building is greater than that consumed in lighting one mile of the average city street with ordinary pendant units.

Street-lighting rates, with few exceptions, have remained practically constant for many years, in spite of the fact that there has been a large advance in the costs of material and labor. The per capita cost of street lighting is generally low and there are few cities spending over three dollars per capita. The average for the fifty best lighted cities is about two dollars, and for the whole of the United States not more than seventy-one cents per capita.

Requirements of an Ornamental Street Lighting System

Since the introduction of the high-efficiency Mazda C incandescent lamp, which has revolutionized street lighting, eliminating the ornamental cluster post of earlier days and relegating the arc lamp to the museum, development in ornamental street lighting has favored the single-light post equipped with suitable lighting unit or post top to distribute and direct the light on the plane of illumination.

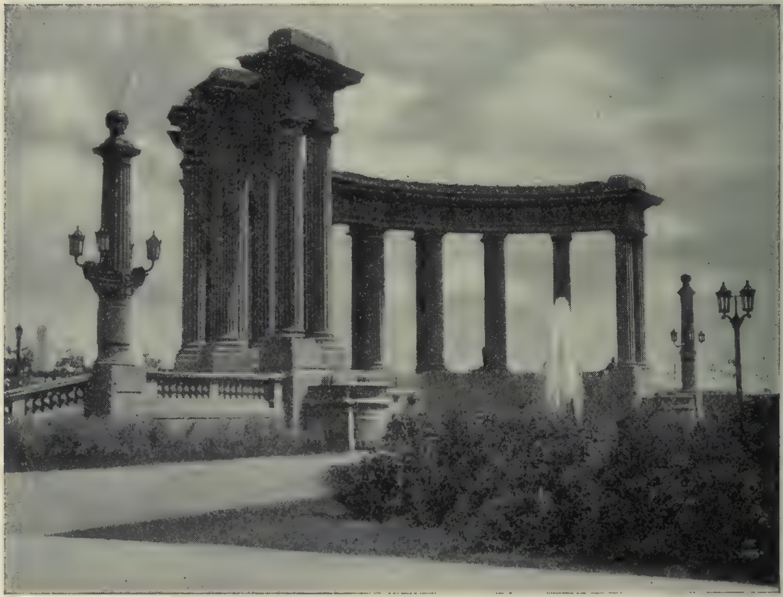


Fig. 1. Lighting Installation at Grant Park, Chicago, Ill.

The first requirement of an ornamental street-lighting system is that, while efficiently illuminating the streets during the hours of darkness, it should be inconspicuous in the day time, blending harmoniously with the architecture of the surrounding buildings. This is very aptly illustrated by the photographs, which show a well designed ornamental lighting system in the city of Chicago, within two blocks of the busiest part of the Loop. (Figures 1 and 2.)

Another important requirement of good street lighting is that the intensity of illumination should be graduated in accordance with the conditions of the various localities and the flexibility of the Mazda system renders it particularly suitable for this class of work. Until the public became aroused to the

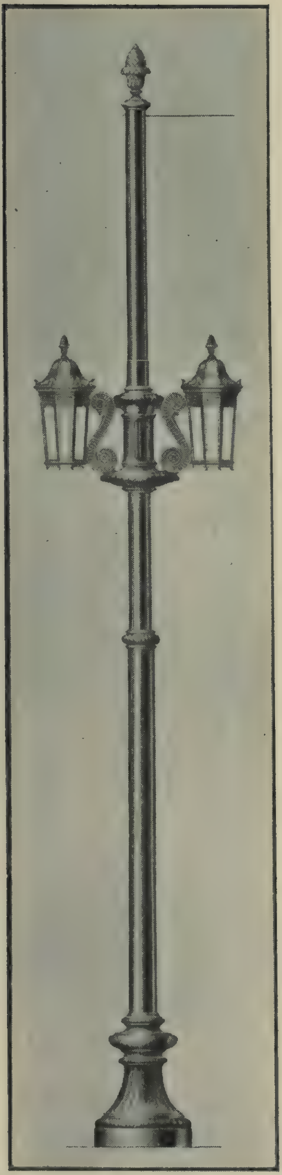


Fig. 2. Trolley Pole with Grant Park Bracket and Lanterns.

Fig. 4. Commercial Post with Octagonal Reflecto-Lux Top.

necessity of well designed and uniform systems of ornamental street lighting, progressive merchants installed, at their own expense, systems of ornamental posts or whiteways, which often resulted in the installation of posts of various designs in different parts of the same city.

This activity on the part of merchants should be carefully directed by the municipal authorities and the uncontrolled installation of whiteways should be discouraged. An ornamental street-lighting system should be considered as part of a plan to beautify the city as a whole and not as means of advertising one section, perhaps to the detriment of some other locality.

Promoting and Financing

There are various methods of promoting the installation of ornamental lighting systems, but the most successful have been thru the Chambers of Commerce or Commercial Clubs. Municipalities are, as a rule, reluctant to consider such lighting until there is a publicly expressed demand.

In a number of states, there are existing laws which permit the establishment of assessment districts for the purpose of taxing abutting property for the installation of special lighting. In such cases usually fifty-one percent of the frontage involved must be signed up to make the petition effective. Street-lighting improvement acts have generally assisted the progress of ornamental street lighting and, where available, should be used. The assessment becomes a taxation and the contract is between the city and the central station, thus insuring a uniform installation with continuity of service, under the control of the municipality.

The assessment of property owners for the up-keep of lighting installations is not new, and the following extract from *Municipal Government* by Frank J. Goodnow, LL.D., published in New York by the Century Company in 1910, page 328, describing Paris in 1666, is of interest:

> The expense of lighting the streets was defrayed also from the receipts of a tax imposed on the householders. Mildmay says: 'Two persons are generally contracted with for this undertaking; the one to find the lanthorns, cords and pullies; and the other to supply the candles; for the streets are here illuminated by hanging lanthorns on the middle of a cord that reaches cross the street; and is fixed to pullies on each side, at about fifteen feet high and about fifteen yards distance from one another. There are sixty-five lanthorns and consequently as many candles consumed each time they are lighted, which is only twenty times a month, being laid aside during the moon-light nights; and are never lighted, but from the last day of September until the first day of April each year; being taken down and set apart during

all the summer months.' Elections were held annually in each quarter of the city by the householders. The persons elected had each charge of fifteen lanterns and paid, as Mildmay puts its, 'Some menial servant or poor housekeeper in the same street to perform the duty; accordingly every evening, as soon as it begins to grow dark, the commissary sends out a person, ringing a hand bell through the streets of the quarter to give notice, as in the morning for cleaning the streets; so now for lighting them; upon which each lanterniers servant immediately sallies out and having a key to the iron box in which the end of every cord is fastened on the sides of the streets, lets down the lanthorn hanging on the same and fixing his lighted "candle therein draws it up again; and thus everyone having only fifteen lanthorns under his care, the whole city is illuminated in a very short space after notice; though the light itself is indeed a very indifferent one."

System of Operation

Owing to its flexibility, the Mazda C lamp is peculiarly adapted to ornamental street lighting, and, when operated on a constant-current series system, it affords an efficient and economical street-lighting unit, easily installed and controlled, giving a range of from 600 lumens[1] (60-candle power) to 25,000 lumens (2500-candle power). Any size lamp within this range may be operated in series on the same circuit without changes in the regulating equipment at the central station, and, with suitable enclosing glassware, a soft diffused illumination or a brilliant sparkling light without glare may be obtained.

The regulating equipment generally consists of moving coil type constant current regulating transformers and control panels which limit the current in the circuits, safeguarding the lamps against surges and, at the same time, insuring that sufficient current will flow thru the lamps at all times to maintain the rated candle-power.

In addition to regulating equipment of the station type moving coil, regulating transformers have been designed suitable for mounting on poles at any point in a high-tension distribution network, thus permitting an ornamental lighting system to be connected to a high-tension line without the necessity of running special lighting circuits back to the sub-station. This improvement in regulating apparatus, which may be operated either from a time switch or remote-control device, materially reduces the cost of installing ornamental lighting systems at a distance from the sub-station. Another method of control for series Mazda lighting is the adjuster or reactance-socket system. This is generally used for small groups of lighting units and is operated from a constant-potential transformer with a reactance coil connected in parallel with each socket. When a lamp burns out, the current is forced thru the reactance coil, introducing an impedance in the line equivalent to the energy absorbed by the lamp, thus maintaining the circuit current constant.

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[1] The Series Mazda Lamp is now rated in lumens instead of candle power and the lumen rating is ten times the present candle-power rating.

The earlier types of cluster posts were usually operated on multiple systems, but, while there are still some ornamental lighting systems installed in multiple, the series system is the one generally adopted. This condition has made the selection of ornamental street lighting equipment a matter for the engineer's serious consideration, owing to the fact that the equipment, unlike the old cluster posts, is operated on a high-tension system, requiring fixtures specially designed for this purpose.

The Underground System

Until the introduction of steel-armored and lead-covered cable, it was customary to lay underground cable in conduits, but modern practice favors the use of steel-armored cable buried in a shallow trench below the curb or in the parkway. The steel-armored cable consists of a copper conductor (usually of No. 8 gage) insulated with rubber, over which is a braided cover and jute filling. A layer of tape is then wrapped around and this is enclosed in a continuous lead sheath, covered with a coating of tarred jute. Around this are wrapped two layers of steel tape, so arranged as to insure the steel cover overlapping when the cable is bent. A serving of jute is placed around the cable and affords protection to the steel tape when placed in the ground. If properly installed, the life of this cable is almost indefinite, as the lead cover forms an efficient protection from water, while the steel armor protects the cable from mechanical injury. The posts are usually wired with rubber-covered and braided cable.

Steel-armored lead-covered cable should be laid in a shallow trench below the curb or in the parkway, if any, and, in this position, it is not likely to be damaged. It is important that ends of the cable, where cut, should not be exposed to the weather. We are all familiar with the precautions taken by cable manufacturers to seal the ends of the cable before it leaves the factory, but, unfortunately, very little care is exercised in this direction when the cable is installed. It is quite common, during the installation of ornamental lighting systems, to see the ends of the underground cable projecting thru the ground, exposed to all weathers, until the posts are installed and connected, with the result that faults are likely to develop at an early date and the installation becomes a source of trouble and expense.

The best way to instal armored cable is to lay it in a prepared trench, leaving a loop at the location of each post sufficiently long to reach the terminal of the disconnecting device in the base of the post and to pour cement around the loop to form the foundation for the post. This is a more satisfactory method than the one usually used of making the post foundations first with the conduit elbows for the cable to be drawn thru, as it leaves the cable intact until the time the connections are made in the base of the post.

A disconnecting pothead should be used in the base of the post and this should be of such design as to thoroly seal the ends of the steel-armored cable and efficiently bond and ground the steel armor and lead covers. It should also be designed so that the post wiring is automatically disconnected from the underground system and the circuit in base of post re-established by a short-circuiting device in the event of the post being accidentally broken. (Figure 3.)

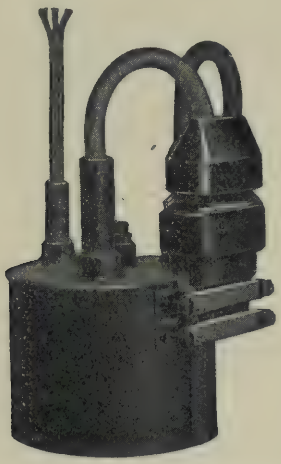

Fig. 3. Combined Safety Coil and Disconnecting Pothead.

It is desirable that a device be used in the top of the post for relieving the terminals of the lamp socket from the strain of the weight of the cable used in wiring the post.

In the constant-current series system of operation, the high-tension current is carried up the post, and, altho when properly installed this is not objectionable, several cities have preferred to use a safety coil in the base of the post so that a voltage equivalent to the voltage of the lamp only is carried up the post.

Safety coils have been designed, equipped with disconnecting potheads, which have all the advantages of the latter device, coupled with the safety feature of low voltage in the post.

Part-Night Circuits

Occasionally, in the interests of economy, it is found desirable to decrease the illumination on the streets after midnight when only protective lighting is required, and this is best accomplished by dividing the lighting system into two circuits, one operating the all-night lamps and one operating the part-night lamps. For this purpose, two single-conductor cables may be laid in the same trench, connecting with alternate lamps or any other combination desired. If preferred, a twin-conductor cable may be used.

Classification of Streets for Ornamental Lighting

In many of the larger cities will be found some exceptionally wide and important streets which will require special treatment; in general, however, for the purpose of determining the correct size of lamp with the best spacing and mounting height, the streets may be divided into three classes: viz., important business streets, side streets, and residence streets. The following table gives approximate data on this subject, which, however, may be varied to meet local requirements:

Type of Street	Size of Lamp in Lumens	Spacing in Feet	Mounting Height in Feet
Important business........	6000 to 15000	50 to 75	12.5 to 15
Side......................	2500 to 4000	75 to 100	11.5 to 13.5
Residence.................	1000 to 2500	150 to 250	10.6

In the important business streets and side streets, the ornamental posts should be set symmetrically opposite each other on either side of the street, while in residence districts the posts should be staggered.

For exceptionally wide and important streets, a greater intensity of illumination is required, with higher mounting, and for this purpose, two-light ornamental posts, for use with 15000 and 25000-lumen lamps, have been developed.

The Use of Trolley Poles as Lighting Units

On streets where trolley poles are in service, the best method of lighting is by the use of ornamental trolley brackets with suitable lighting units, either with single or double arm, which may be attached to the trolley poles, presenting a very attractive appearance and eliminating the necessity of cluttering up the streets with additional posts.

Another method of adapting trolley poles as ornamental lighting units is to encase the pole in an ornamental cast-iron shell with ornamental brackets attached. An attractive unit has been designed with double brackets immediately below the trolley span-wire and a single light at the top. The span-wire is attached to the trolley pole thru a hole provided in the capital of the top lighting unit.

Types of Commercialized Ornamental Posts

Ornamental posts may be divided into three classes: viz., cast iron, concrete, and pressed steel.

The earliest ornamental cast-iron post, the history of which is preserved, was installed in the Taj Mahal, Delhi, India, upwards of sixteen hundred years ago, and stands today a monument to the durability and lasting qualities of cast iron.

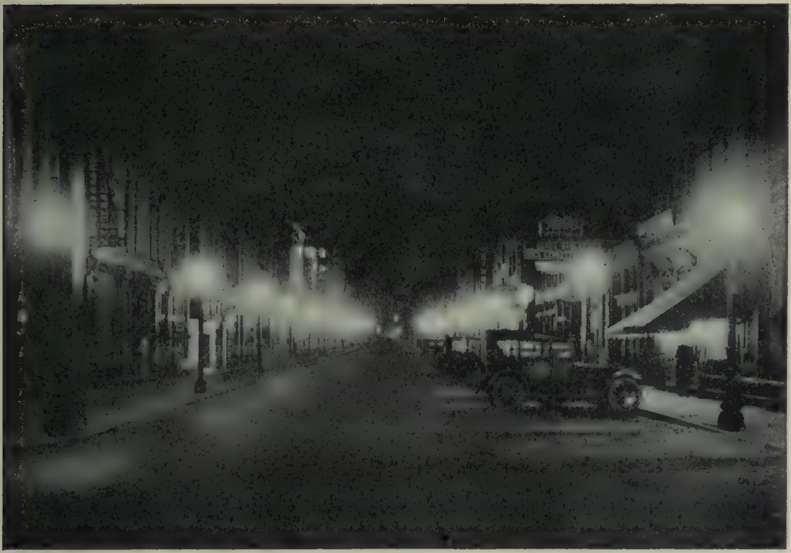

Fig. 5. Lighting Installation at Lima, O.

Cast-iron posts will not corrode, neither will they chip or crack under extremes of temperature. They are designed to withstand severe shocks, such as might be received in ordinary street traffic, and present the slender and graceful appearance so desirable in ornamental street-lighting units.

Concrete is one of the most durable materials used in construction work, but it has been found that ornamental posts of this type must be of very heavy and substantial construction to withstand extremes of temperature. Unless manufactured with the greatest care, concrete posts will be found to chip and crack in northern climates.

Pressed-steel posts generally consist of a shaft of corrugated pressed steel, mounted on cast-iron foundation, with an iron capital, the whole bolted together with three tie-rods passing thru the center of the shaft. This type of post, owing to its construction, presents a massive appearance, but the shaft is readily dented and bent by shocks which would leave cast-iron posts unaffected.

The Mazda C Lamp

Until about the year 1913, the filaments of all commercial electric incandescent lamps were operated in bulbs from which practically all the air and gases had been removed. The evacuation of the bulb accomplished two purposes: viz., it prevented the filament being consumed by the oxygen of the air and also prevented the loss of heat by convection. As the temperature of the filament is raised, the light emitted increases much more rapidly than the energy consumed, but, on the other hand, the rate of evaporation of the filament is increased.

In the Mazda C lamp, the rate of evaporation is reduced by the introduction into the bulb of inert gases, thus permitting the use of a higher operating temperature. Convection losses are reduced by the use of a concentrated type of filament and this renders the use of the Mazda C lamp specially suitable for street lighting purposes.

Constant-Current Series Circuits

Alternating current series arc-lamps were operated on circuits of either 6.6 or 7.5 amperes and, in consequence, series lighting regulating equipment designed for these ratings became standardized thruout the country. Series incandescent lamps were made for use on these circuits in ranges from 60-c.p. to 1000-c.p., but the larger size lamps did not come into commercial use until the high-efficiency Mazda C lamps, operating at 15 and 20 amperes, were introduced. These lamps, owing to the increased size and rugged construction of the filament, have a longer lamp life than the straight series type and are generally adopted for ornamental street-lighting systems, except in residence districts.

Since the standard rating of series alternating current circuits is either 6.6 or 7.5 amperes, individual auto transformers to step up from the line current to that required by the lamp have been designed, and these are generally mounted in the post top, immediately below the socket. In cases where a safety coil is installed in the base of the post, the auto transformer is omitted and the safety coil serves as the step-up transformer. The high-efficiency Mazda C lamps are made in the following sizes:

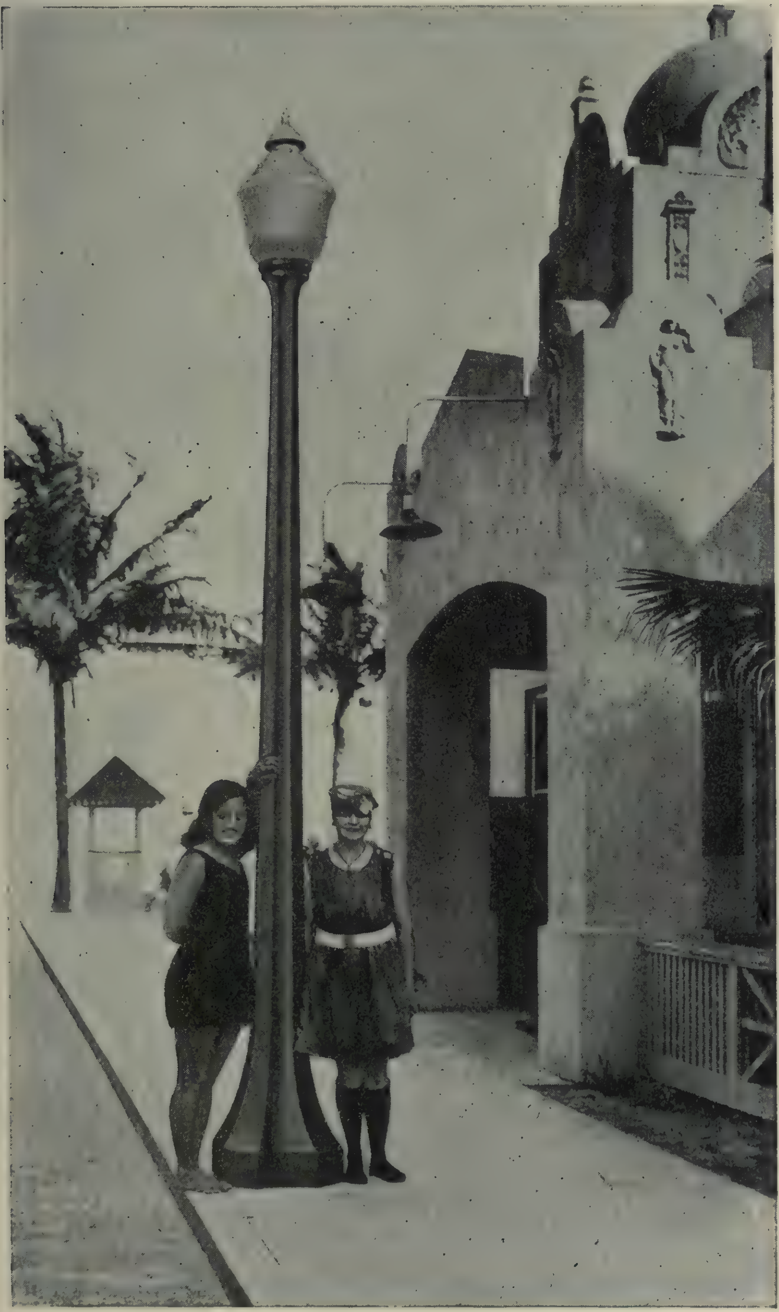

Fig. 6. Arcadian Post with Sol-Lux Top, Miami, Fla.

Lumens	Amperes	Average Volts	Watts	Light Center Length in In.
4000	15	14.9	223.5	9.5
6000	20	15.5	310	9.5
10000	20	25.9	518	9.5
15000	20	37.6	752	9.5
25000	20	60.7	1214	9.5

NOTE: The nominal candle-power of these lamps is one-tenth their lumen rating.

The Light Unit

The problem of street lighting is not like that of lighting a room, where the ceiling and walls reflect the undirected light, and provision should be made in the lighting units to direct the light emitted above the horizontal to the plane of illumination. With ornamental post lighting, however, it is desirable that a small amount of light from the upper hemisphere should be directed against the fronts of adjacent buildings, and that glare should be, as far as possible, eliminated.

Glare, within the range of vision of the pedestrian or vehicle driver, should always be avoided. It causes the pupil of the eye to contract in an effort to protect the delicate mechanism of the retina, thus preventing the observer from seeing as well as he would be able to do with a light-source of lower intensity, but more perfect diffusion. We are conscious of this phenomenon when entering a moving picture theatre from a street flooded with sunlight,—at first no details can be seen, but gradually, when the eye becomes accustomed to the light, or, in other words, when the pupil becomes dilated, permitting more light to enter the eye, the interior details become visible.

The problem of designing lighting units of high intensity, with a minimum of glare, has been solved very satisfactorily by the Reflecto-Lux post tops recently introduced. (Figure 4.)

The Reflecto-Lux units are the very latest in ornamental post tops and they have been specially designed to distribute a flood of light on the streets, with a small amount upwards to illuminate the fronts of adjacent buildings.

The units have been developed for super whiteway lighting, with 10000 and 25000-lumen lamps, or they may be used with smaller lamps, if desired.

The light emitted by the Reflecto-Lux unit is brilliant and sparkling, and the panels, which are of ribbed glass, assist in diffusion and in the elimination of glare.

The distribution is obtained by upper and lower parabolic reflectors which direct the light outwards; in addition, a portion of the light in the upper hemisphere is re-directed by an opal glass band around the upper portion of the lamp, or by a band of enamel on the lamp itself.

In the post top, the lamp burns in a tip-up position, and is easily accessible for cleaning thru the top cover, which is hinged.

With the variety of ornamental street lighting fixtures now available, the possibilities of efficient and artistic lighting for the "City Beautiful" are unlimited, and public spirited men who are guiding the destinies of American cities will find an easy solution to their problems by consulting the manufacturers of these devices, who have devoted many years of research to the design of suitable apparatus.

ELECTRICAL CONDUITS OF BALTIMORE

By Charles F. Goob, Chief Engineer Electrical Commission, Baltimore, Md.

History

With the exception of a small amount of underground conduit constructed by the Chesapeake and Potomac Telephone Co. in 1889 and 1890, and the construction of conduits by the city to make possible the use of the ducts of the telephone company, a proportion whereof the city was privileged to use free of charge, and the small amount of cement-lined pipe in the bed of the Northern Boundary of the city, which was constructed by the Brush Electric Co. in 1895, there were no efforts made by the city to require wire-using companies to place wires underground, and to remove overhead equipment.

The experience of the city at this time, in undertaking to force the removal of poles and overhead wires, was such as to indicate that the only way to obtain results was for the city to assume control of the situation, provide the necessary money for construction and to require all wire-using companies to place their wires underground, all under the same conditions. As a consequence an act was passed by the Legislature of the State in 1892, which empowered the Mayor and City Council to appoint a commission, consisting of the Mayor as chairman, the City Register, and the President of the Fire Board as members to carry out this purpose. However, no appropriation was authorized in this Act, but an enabling Act was passed in 1896 by the Legislature authorizing the City to issue its credit to the amount of $1,000,000, subject to the approval of the majority of the registered voters of the city. The ordinance submitting this appropriation to a vote was passed by the Mayor and City Council and approved by a majority of voters in the general election of 1897.

This preceding action was to authorize the City to enter upon this work and to borrow $1,000,000 for meeting the cost of this construction, therefore, after the approval of the voters of the issuing of the necessary funds, it was necessary to appoint an Electrical Commission, and delegate to it the specific and detailed authority for carrying out the provisions of the Act of 1892. Whereupon, three ordinances were passed by the Council with the following provisions:

1. To require wires (except trolley wires) to be placed underground.
2. Providing for the appointment of an Electrical Commission to construct a general system of conduits.

3. To provide the furnishing to the Electrical Commission of data by the different companies maintaining poles and overhead wires in the city of Baltimore.

The organization for the work was begun by the appointment of a chief engineer on Oct. 1, 1898, and the period from Oct. 1, 1898 to March 1, 1899 was consumed in the preparation of plans and necessary details preliminary to the beginning of actual work.

The obligations imposed upon the Commission by the above ordinances were such that it was necessary to complete the construction of conduits in certain defined areas of the city before any notices could be issued for the removal of poles and wires from the streets. For this reason practically the whole of the years 1899 and 1900 was consumed in constructing conduits preparatory to sending out notices, and it was not until Feb. 18, 1901, that the first notice was issued for the removal of overhead equipment. Progress in this line was temporarily checked by the fire of 1904, which to a large extent affected the natural expansion of the system, both by the loss of service to the various companies involved and also by the rebuilding of conduit lines in the burnt district, caused by the changes in grade made by the city thru the Burnt District Commission.

Organization

The system followed in organizing the work has been to divide it into two principal parts: First, the part known as General Expenses and Monthly Payroll, and second, Construction Costs and Weekly Payroll. Under the latter are charged all costs and expenses which would be borne by a contractor where the work was done under contract. Under the former heading are charged all items of salaries and expenses which would represent the cost to the department of administering the work were it done under contract.

Determinations

At the same time that the laying down of working plans was being prosecuted, information was sought of the various companies doing business in the city and using the streets for poles and overhead wires, who were to use the city conduits when completed. This information was obtained after the consolidation of two street railway companies, three electric light companies, the independent telephone company, and two telegraph companies, who would pay revenue to the city for duct rental, and from the Police and Fire Alarm, who were to occupy the conduits free of charge. It is to be noted that the present lessees are nineteen productive and four non-productive in number.

Capacity

After a determination of the actual amount of space required by each prospective user of the system, it was determined that the total capacity should never be entirely occupied, for the obvious reason that underground cables in constant operation are subject to more or less deterioration, and there should be sufficient number of spare ducts so that in cases of emergency, a suitable cable may be drawn in to replace the one which would otherwise cause interruption to service while undergoing repair. This proportional number of ducts was determined as approximately 50 percent, with the minimum of four ducts.

Separate and Combined Circuits

The character of service is naturally divided in two classes, one class that is known as high-tension cables and the other as low-tension cables; the high-tension circuits being used to transmit power from central station to sub-station, and the low-tension from substation thru the various step-down devices to subscriber. Also included in the class of low-tension circuits are the telephone and telegraph.

The municipal-conduit system has been designed to accommodate both the high-tension and the low-tension circuits, due to the fact that, while a high-tension wire in close proximity to one carrying low voltage would tend to impair the service thru the latter, it has been determined that a low-tension current can be transmitted thru a complete metallic circuit thru the modern low-tension cable and the effect of a high-tension cable in the next duct is entirely eliminated.

Liability of accident to employees, whose business it is to handle and repair cables, is small, due to the fact that they have a full appreciation of the danger, and, being incident to their trade, they of necessity are expected to and do exercise due care. The records of this Commission do not disclose a single accident due to the repair of high-tension cables.

Construction

The construction of the system is primarily of vitrified clay conduit of various duct sections on which are laid one or two ducts of 2-inch fiber. This material is laid in an envelope of concrete, the thickness of which is determined by the depth of construction, location, and amount of traffic. Manholes are located at the various street intersections; but in cases where this distance exceeds 450 feet another is inserted. These manholes are roomy and of sufficient size for the splicing of new or the repair of old cables.

Ventilation

It is extremely difficult to prevent gas from forcing an entrance into conduits and manholes, and it is doubtful if any method would be absolutely effective, other than preventing leakage into the soil. Methods of ventilation for projects of this sort can be attempted:

1. By the prevention of gas entering the system as far as possible by wrapping the joints of conduit with muslin dipped in a combination of pitch.
2. By the use of a porous material to take up the greater volume of gas by absorption, such as charcoal or coke.
3. By artificial or natural ventilation.

The first method in addition to that part of the third which pertains to natural ventilation, has been adopted by this Commission. The natural ventilation has been effected by the use of perforated covers on alternate manholes and 5-inch connections from the bases of alternate trolley poles into the various manholes, where they are accessible for use. In the cases where steam mains cross the conduit lines, excellent results have been obtained in reducing temperature by the installation of a ventilating manhole into perforated cover at the intersection of the conduit line and steam main. It has been determined that by the use of the perforated cover and the vent thru the trolley pole, a draft of ¾ inch of water has been induced, sufficient to remove the volume of air in any manhole in ten minutes.

Electrolysis

The different interests which make use of the public streets are really vitally interested in the manner of the operation of each. Gas and water pipes and all sub-structures which have metals in their make-up in contact with earth, are just as much interested in stray or earth currents from the tracks of street railways operating an overhead trolley system. To the extent to which the return of these railways is defective, to just that extent are other metallic structures subject to deterioration and decay.

To be entirely effective within human means, the return of current to the power station must be confined to the tracks or to an auxiliary or supplemental return if track conductivity is insufficient. This necessitates that the conductivity of the combined return system shall be so much greater than that of the underground metallic structures as to render leakage inappreciable in amount.

Inasmuch as the effective conductivity of underground structures is largely reduced thru non-metallic contact, a large measure of remedy is found in the well bonded track. The better the track bonding, the less danger of deterioration in pipes occupying the same street. It is to be noted that to carry out this principle the United Railway of this city has in operation a well defined schedule in the bonding of tracks and the troubles from that source have been reduced to a minimum.

The effect of stray currents, or as it is technically known, electrolysis, upon gas and water pipes is so frequently demonstrated in cities other than Baltimore, that it is not necessary to explain in detail. This action can be thus briefly described and may be stated in three fundamental principles.

1. There is no deterioration in a body from electrolysis if a conductor carrying the current of electricity is perfectly bonded.
2. No injurious effect is produced at points where current makes a positive contact with a conductor, namely, where current flows into the conductor, no matter what may be the quality of the contact.
3. Where current makes negative contact with a conductor, namely, where current flows away from the conductor, the current at the point of leaving decomposes the chemical salts in the soil, the elements of which attack the metal and continue as long as current flows and chemical salts exist.

It therefore follows from No. 3 that the number of points where electrolytic action is set up is governed only by the number of times the street-railway currents are shunted around the track by pipes, etc., and the extent of damage possible is governed by the amount of current so shunted. Were electrolytic action to continue, it is but a matter of time, and how much cannot be estimated with any degree of accuracy, when all underground metallic structures will show signs of serious physical depreciation. That this destructive action exists has been apparent during the progress of cable construction, and while there are no absolute evidences of bridge and building deterioration, yet the process is going on from year to year.

At the present time a committee has been appointed, consisting of the chief engineer of the Electrical Commission and the water engineer, to confer with the Bureau of Standards with the end in view of making a complete electrolysis survey of the City of Baltimore, the findings of this Committee to be reported to the Chief Engineer of the city for action.

Loans

For the construction of the present subway system, it has been necessary to have authorized for expenditure, by the majority of registered voters of this city, the amount of $6,000,000, and in the expenditure of this money, nearly 18,000,000 duct feet of conduit and 8,000 manholes, junction boxes and distributing boxes, have been constructed; and the revenue for the entire period of construction of $2,261,043.93 has been obtained. It would appear from these figures that quite an appreciable return has been realized from the money expended, but after taking into account the necessary money that must be had to take care of the sinking fund and interest charges, this revenue has been approximately 5% on the money invested.

The construction of the conduit system, as laid out to comprise the boundaries of the old city of 31 sq. mi. would indicate that 5.63 sq. mi. have been entirely completed, 2 sq. mi. 90% completed, .5 sq. mi. 80% completed, .66 sq. mi. 70% completed, and 22.21 sq. mi. 20% completed. Should the program as laid out for the fiscal year of 1921 be carried out, it is estimated that a little over 3 sq. mi. will be completed and 2,665 poles will have been removed.

Baltimore Fire

Prior to the great conflagration which occurred in this city on Feb. 7th and 8th, 1904, there was constructed in the district devastated by fire, 13,825 feet of trunk conduit, 26,325 feet of distributing conduit, 49 manholes, 123 junction boxes, 230 surface boxes, and 876 separate house connections.

After a careful scrutiny of the conduits in this district immediately after the fire, it was determined that there was not the slightest damage to any structural part of the conduits, including manholes, in spite of the intense heat and enormous weight of masonry and iron that fell upon them, in some places being heaped upon them to a height of 8 and 10 feet. Nine-tenths of all the important cables of the various companies using city conduits were in this burnt district, including most of the important circuits of the Police and Fire Alarm Telegraph, and following is a brief abstract of the records of this office of all cables of the various lessees.

United Ry. & Elec. Co.—This Company was most seriously crippled not only because of the destruction of its overhead trolley system in the burnt district, but that portion of the Pratt street power house, which furnished most of the track current to the system, was entirely put out of operation. The feeders which had carried this current underground, after being cleared of all burnt trolley taps, were at once put in service, conducting current in the reverse direction from the power house of the B. & O. Ry. The main cables in the conduits were not damaged.

United Electric Light & Power Co.—The city street lights within the burnt district had been supplied by underground connection since 1902. This lamp is suspended from a gooseneck mounted on the top of a wooden post. The lead covered cables connecting the lamp pass from the conduit in a hole bored thru the center of the post, thence thru the pipe forming the gooseneck to the lamp terminals. The unique feature of this system was that altho the lamp posts were of wood and all were more or less charred or burned, the majority of them and the connections were such after the fire that the circuits were readily closed and those left standing were burning on Monday night, the 8th, before the fire had entirely run its course. It is to be noted that all the lamp posts which were burned down were temporarily replaced, and the same number of lamps were burning one week after the fire as before, the cable system being absolutely uninjured below the street surface.

Conclusions

We learn as a result of this experience:

1. The only sane and sure investment in the transmission and distributing system is one beneath the surface of the street.
2. Any reasonably well constructed system of underground conduits is proof against damage and interruption to service even when subjected to such unusual stresses as occurred during this great conflagration.
3. With underground house connections, the only damage sustained is at the house end of the connection, and the house being destroyed, the revenue earning capacity of the connection is gone, but it is perfectly feasible and practicable to so protect the house end of the house connections that a new splice can be made into the cellar instead of going back into the cable and distributing line.
4. With reference to ventilating the system as protection against gas explosions, the only recommendation to be made is one looking to a continuance of effort to provide an efficient method of sealing house connections at both house and service box ends to prevent fire in buildings from communicating with an explosive mixture in service boxes.
5. The provision already made for the ventilating of trunk manholes of the system is adequate.
6. House to house system should be extended on certain streets.
7. Although nearly every pole and pole connection within the burnt district was destroyed, the method of pole distribution is perfectly practicable and satisfactory in residential and business sections where service connections are infrequent and where house to house system would not be economical.
8. No pole lines carrying wires should be permitted on any street in the built-up portions of the city.
9. Over head wires will not answer.

REPORT OF COMMITTEE ON PUBLIC MARKETS

D. J. Sweeney, Chairman, Buffalo, N. Y.

Your committee has made an extensive inquiry into conditions in more than one hundred American cities by direct correspondence with market managers and thru data published by the census authorities at Washington.

Altho municipal markets have been maintained in American cities from about 1740, no city, apparently, is entirely satisfied with its market situation.

Primarily a meeting place for the producer and the consumer, the city market, save in the smaller cities, no longer serves that purpose.

Those entrusted with market management, tho striving to retain in some degree at least its original function, seem unable to keep out the huckster, the broker and the jobber, whose presence in the food-distribution system of large municipalities accounts for a proportion of the increased cost of living.

Practically every municipal market superintendent interviewed by your committee entered a complaint, in greater or lesser degree, against the huckster and fake-farmer evil of the municipal market.

Conservatively reviewing the reports from the leading American municipalities the conclusion is forced, not drawn, that the municipal market has lost almost entirely its original purpose, but, despite its failure to bring the producer and the consumer together, it still remains a valuable agency in the food-distribution system of the country.

The municipal market can justify itself only by supplying to the people of a municipality advantages in quality and price of food products over the privately owned market or chain store system. Indeed, the latter in sanitary condition, in arrangement, and in management frequently equals and sometimes excels the public market but, in the judgment of your committee, if the field were to be turned over entirely to chain store or private market enterprises and the public market abandoned, these privately owned chain stores would seemingly assume a monopoly and the public would lose a valuable institution for the regulation of the prices of food products.

An investigation conducted by the city of Buffalo of the prcesi charged for commodities sold in the municipal markets as compared with the prices charged in privately owned markets thruout the city established, very thoroly, the fact that the city market prices were not materially lower than those charged in the private market; but this additional fact was likewise fully demonstrated, that the market prices to a very great extent in all districts, save what is commonly referred to as the silk stocking district, regulated the prices in the privately owned market and served as a safety valve in the fixing of the prices of food stuffs for the community.

Many would conclude from the facts so far established that the municipal market, (1) having lost its original function of bringing the producer and consumer together at a common meeting place, (2) having no superiority over the private market in sanitary equipment and management, in quality and variety of food products, (3) and not lowering prices, might readily be abandoned as a municipal burden. Indeed, many cities, from time to time, have abandoned their public markets and others have never entered upon that enterprise.

The first market erected, as far as there is any record, was in the city of Boston in 1658. This building, a wooden structure, was erected from the proceeds of a legacy and a subscription. The building was destroyed by fire in 1711, and a somewhat larger brick structure was erected in the following year. This market building was destroyed by fire in 1747. In 1734 the town voted to erect three market houses, one of which was at the town dock. In 1737 that structure was pulled down by a mob, and the town ordered that of the other two, the South Market be leased for shops and the North Market be removed. In 1740 Peter Faneuil offered to build a market house "provided the town would accept the same and make the proper regulations." The offer was accepted by a vote of 367 to 360 and the market house was turned over to the town authorities in 1742. In testimony of the town's gratitude to Peter Faneuil, and to perpetuate his memory, the town voted that the hall over the market be named Faneuil Hall, which subsequently grew famous in American history.

The opposition to regulated public markets in Boston continued, however, as is shown by the fact that a petition was presented in 1746 to close the market. This petition did not meet with success at that time, but the market was closed in 1748, and was closed again in 1762, but was reopened the following year and, tho the building has been remodeled on various occasions since that time, the lower part is still used as a market place. What happened in Boston for and against the public markets in the early days has happened in practically every American city where public markets have been conducted, with more or less fervor, thru all the intervening years.

In most American cities, within the last ten years, a substantial improvement has been made in the arrangement of market areas and the construction of market buildings. Practically all of the newer buildings are equipped with refrigeration plants and storage quarters, all of which are great aids in checking food wastes, aiding in food distribution, and consequently keeping down the cost of food products.

The supporters of the public markets answer the complaint against municipal market operation as follows:

To the first charge that the market has lost its primary purpose, they point out that not more than twenty per-cent of the food products consumed in a big municipality are produced in the territory surrounding that municipality within a radius which would enable the producer to bring his products to the city market. Of this twenty per-cent, they point out that fully fifteen per-cent is sold by the farmer to the grocers, chain-store men and hucksters, and that not more than five per-cent is sold upon the public market to the consumer by the producer himself. The producer seeks to dispose of his load in bulk and his first choice is the city grocer. The farmer or gardener no longer attempts to dispose of his produce to individual market customers. In his place, however, the markets have filled up with middlemen tenants in market stalls and spaces who buy from the producer and from commission merchants. The rental of those stalls is nominal. Most cities in the construction of their market buildings avoid excess costs and fix the stall rental, refrigeration and storage charges at a figure which balances as nearly as possible the costs properly chargeable against the enterprise. The idea is not to seek profits in the market management but rather to have low rental charges reflected in the market by lower food prices to consumers. Market rentals paid by dealers are usually passed on to the consumer and any excess is felt in the added costs of commodities purchased on the market.

City markets present a great abundance and variety of food products for the housewife. Most stall owners are willing to operate on a small margin of profit, having no deliveries to make and operating on a cash basis. Their profits on a small margin are substantial by reason of the vast volume of business which may be transacted. It is not uncommon for a twenty-foot-front stall in a leading city market to average $1500.00 worth of business in a single market day. This great public patronage would seem to indicate that the goods are desirable and the prices reasonable, and to justify the continuance of the public market, even tho the market no longer enables the consumer to deal direct with the producer.

To the second charge that the municipal markets are not as sanitary in equipment, or successful in management as private markets, the reply is neither so impressive nor so forceful as the first. Municipalities are adopting market regulations, however, which are rapidly improving the sanitary conditions of public markets, and in many cities the sanitary arrangements are at least equal, if they are not superior to, the conditions in private markets.

The answer of the market supporters to the third complaint is that if the municipal market were to be abandoned, prices would immediately advance in the privately-owned markets. Consequently, they argue, the municipal market is of immense benefit to the public in keeping within reasonable bounds the cost of food supplies in the large municipalities.

After considerable investigation your committee has reached the following conclusions:

First, that the municipal market is a desirable institution in the distribution of food products in American municipalities.

Second, that the occupation of farmers' wagon spaces on public markets by hucksters and fake farmers should be completely and entirely prohibited. There is no place in the food distribution system for the huckster, either on the markets or on the public streets, except as a distributer of 'seconds' or slightly spoiled products, and he should be conspicuously known as such.

Third, rentals and other charges must be so fixed that the receipts from these sources will meet the costs incurred by the city for its markets. A municipal market should be self-supporting, but should not be operated for any considerable profit. by reason of small rental charges and little overhead expense, stall owners, or lessees, are in a position to make excessive profits, unless prices are continually and effectively supervised.

Conceding the practical necessity of a middle man in present day food distribution, the aim of the municipality should be to make the cost of such handling as inexpensive as possible. In most cities the economic wisdom of low rentals and carrying charges in the operation of municipal markets is recognized, but there can be no public value from all this if stall owners be permitted to make excessive profits. Political favoritism in this department, as in all others, is all too frequently an expensive and destructive agency in municipal management. The success of the public market hinges on this single point, the supremacy of business over political government. Some cities have conceived the idea of allotting one stall for the handling of each of the commodities sold on the public markets for operation as a municipal activity, i. e., the stall to be operated by city employees and this stall to regulate and fix the prices for like commodities thruout the market; other cities rely on the supervision of market authorities and the law of supply and demand to regulate the profits of the stall owner; and in some localities municipal ownership of the entire enterprise is advocated.

In the judgment of your committee the public market will be economically and successfully operated and the public benefited by its operation wherever the city administration is conducted on sound business lines.

DISCUSSION

A MEMBER: Is there any city in which the public market is conducted as a department of the city?

MR. SWEENEY: The Census report covering this shows no instance and I know of none. About the only mission the market has is as a safety valve on prices.

A MEMBER: Do I understand that your committee would advocate the city-owned market if politics were eliminated?

MR. SWEENEY: We would not. The market forces are a political influence in many cities but where it can be eliminated so that the supervision of the market does not become a political job and the official is so far removed from political influence that he can exercise a rigid and substantial business economy, his control over the stall owners should and will be sufficient to enforce proper regulations of the fixing of prices. We believe that in such cities the law of supply and demand would govern the prices and that the market will be a valuable institution in the city's food-distribution system.

REPORT OF COMMITTEE ON WATER-WORKS AND WATER SUPPLY

STATUS OF WATER SUPPLY PRACTICE

Nicholas S. Hill, Chairman, New York City

Personnel

Every municipal officer from the mayor down knows that the water-works of his town represents a large investment, but it is extremely doubtful if he stops to realize the importance of this department to the welfare of his community. It is certainly the most important of the public utilities which a complex modern civilization has made necessary, even in small communities, and there is a grave question whether it is not the most important of all municipal departments. There is certainly no branch of municipal endeavor which surpasses it in its intimate relation to the welfare of the people, for a proper water supply is absolutely vital to the very existence of every citizen. The health and safety of every resident depends upon it and the time has come when the public, which owns the great majority of the water-works in this country, and municipal officials in particular, should be brought to a realization of the responsibility which they intrust to water-works officials and to recognize the folly of denying those officials the compensation and other advantages of men performing like work for private industries.

It is difficult to estimate the total sum of money invested in water supplies in the United States, because statistics are not available from which such information can be gleaned. It is a fact tho that, except for playgrounds and parks, the money invested in no other branch of municipal activity even approaches in amount that invested in water works plants. It is absolutely essential, therefore, that the men charged with the responsibility of the administration of water departments should be qualified for the work on economic grounds alone. It is penny wise and pound foolish to select mediocre water-works officials simply to save a small amouut in the salary account when, on the contrary, only men trained and experienced in the specific work of water-supply management should be engaged.

While progress in the administration of water-works has been made, there is a marked lack of expert supervision due to the inadequate salaries paid to municipal employees of the water-works departments. Specifically, the results obtainable thru expert supervision of a water works are:

1. Better service.
2. Reduction in cost of operation,
3. Proper anticipation of future requirements, and
4. Improved design.

Better service means an ample quantity of pure and clear water for domestic and industrial purposes and safeguarding the community against disastrous fires. Decreased cost of operation means supervision of all details of operation in such a manner that effective service will be rendered at minimum expense. Anticipation of future requirements means that all necessary increases in the supply and equipment will be foreseen so that they may be provided before the community is reminded of its needs by destructive fires, inadequate equipment, or disastrous epidemics due to the pollution of the water. Improved design will result from expert knowledge of operating conditions.

Ownership

At the present time about four-fifths of the public water supplies are municipally owned and, due to the intimate relationship between the water supply and public health and safety, which differentiates a water utility from other utilities, there is a growing tendency towards municipal control notwithstanding the fact that privately administered water plants are as a rule less costly than publicly owned plants. The public is willing to pay the price of municipal extravagance to obtain the security which it feels results from municipal ownership.

Economic Development

Municipal water plants as a rule, however, are notoriously inefficient at present and are operated on absolutely unsound economic principles, a condition for which there is no good reason and which will be remedied as soon as public opinion is developed to a point where it appreciates that when a city elects to furnish water thru a municipal agency it acts in a private rather than a governmental capacity and should, therefore, operate its water-works on the same economic principles as those on which a private utility would operate. No distinction whatever should be made between a municipal plant and a private plant so far as its management and control are concerned. Both have the same function. A municipality is authorized by statute or its charter to furnish its inhabitants with water, which it may do directly thru the agency of the committee, water board, or official in charge of the water-works, or thru the agency of a private water company. The only difference between the publicly and privately owned plant is the one of the agency selected to provide the service and, therefore, both should be governed by the same fiscal principles, and the municipality should make the same reasonable charges for water that a private corporation would make when serving the public.

The development of scientific rate making has been coincident with the advent of public utility commissions. Prior to the establishment of these commissions there was no attempt to apportion the costs of water service equitably between the different classes of consumer. It is true that the scientific rate schedules recently established by the public utility commissions have had to do with private water companies, but there is no reason why the same scientific principles should not apply to municipal rates, and it is high time that municipal plants establish scientific rate schedules to secure adequate revenues and true equity between different classes of consumers.

A privately owned and a municipally owned water-works plant must be governed by the same economic principles. By that I mean to say, whether a plant is publicly or privately owned it is necessary that the revenues should equal the cost of the service if that plant is to give proper service, that is, that the revenues should be sufficient to pay interest and sinking fund charges in the case of a municipal plant, or their equivalent, a fair return and depreciation reserve in the case of a privately owned plant, plus operating expenses and taxes. This is a basic principle and cannot be contraverted, and every charge which is made for water should be based on this fundamental principle that the revenue must equal the expenses.

It may be, of course, that in a municipal plant all of the money is not taken from one pocket, that is, from the water rates. Some of the revenues may come from water rates and some from general taxation, but in a properly devised system of charges for a private water company some of the revenue should come from water rates and some from taxation, and the amount of revenue which should come from the water rates and the amount which should come from taxation, if costs are equitably distributed, should be the same in a given location whether the plant is municipally or privately owned.

Notwithstanding the correctness of the principles above stated, there is no municipal plant in this country today in which the rates are justly apportioned between the water consumer and the taxpayer. In some municipal plants the revenues derived from the water rates are in excess of those required to operate and maintain the water department and to pay interest and sinking-fund charges on the bonds issued to pay for the cost of the water plant. The excess earnings are turned into the city treasury for general purposes and in effect reduce the tax rates. In this case, the water taker, as such, is required to pay for the property benefits which the taxpayer receives from the water department. In other municipalities all of the interest on the bonds issued for water-works purposes is paid from the tax levy and the revenue from the water rentals is applied to operating and maintenance expenses without any effort to establish a just relationship between the amount derived from water rates and the amount derived from taxation. In other municipalities the revenues from the water rates are not sufficient to pay the operation and maintenance costs and every year the deficiencies of the water department are made up from the general tax levy without any attempt to establish a just relationship between the revenues derived from water rates and those derived from taxes.

These practices are not only inequitable, but they tend to decrease the sense of responsibility of the officials in charge of the water department. If the proper sense of responsibility is to be instilled in the minds of the officers of municipally owned utilities they should be made independent, self-sustaining institutions in the same manner as a private utility. The water department should be properly credited with all revenues derived from the sale of water, whether to private consumers or to the municipality itself, and charged with all costs incident to such supply, including interest and sinking fund charges, and the water department should be made to so regulate its rates that it will be enabled to do the necessary financing to add extensions and improvements required for additional service.

In making this statement it is pertinent to reiterate that some of the costs of the water-works plant should properly be derived from taxes. For example, fire-service revenue should come from taxes because fire service is a property benefit and should not be assessed upon the water taker as such. The proportion of the expenses chargeable to fire service in a given plant should be determined and raised from taxation in the same manner, whether the plant is publicly or privately owned.

There are other costs which are a direct property benefit and which should be paid from taxation, but the subdivision of costs between the taxpayer and the water taker lends itself readily to scientific allocation and the water rates should be based on the principle of equitably distributing costs among all classes of consumers.

There is no aspect of the problem of water-works management and maintenance which has been given so little attention on the part of municipal officials as the economic aspect of the problem has been given, and there is a great opportunity in this country for placing municipally owned water-works on a sound financial basis by the establishment of rate structures which will not only provide the money necessary for their maintenance and operation but which will not unjustly and unfairly discriminate between different classes of consumers.

Uniform Accounting

The necessity for a uniform scheme of accounts and reports for water-supply enterprises has been appreciated for a long time. As early as 1910 a Committee of the American Water Works Association reported on such a scheme of accounts and reports. Unfortunately, the uniform system of accounts and reports recommended by this Committee and adopted by the American Water Works Association was not well adapted for the purpose for which it was intended and was not, therefore, generally adopted. It is almost impossible today to compare the results of the operation of water-works plants in different places.

It is true that the public utility commissions in the various states have prescribed uniform systems of accounting, but in many states the public utility commissions have no control over the accounting of municipal water-works plants. Such a condition is unfortunate, as the benefit to be derived from comparative studies of operating costs and expenses, based on a uniform system of accounting which has been developed along scientific lines, is a prerequisite to the establishment of equitable and just rates. It is true today that the accounts of almost all municipal water-works are so kept that it is impossible accurately to ascertain the sources of revenue and the purposes for which this revenue is disbursed. This probably in a large measure accounts for the inequitable water rates which now exist in most municipalities and it should be the object of municipal officers to establish a proper system of accounting, based upon the practice of the public utility commissions in the states in which they are located. This is not only true with relation to water-works accounting, but to municipal accounting in general, and it is the opinion of your Committee that the cost of municipal operation in general could be greatly reduced if the accounts enabled the heads of municipal governments to segregate costs properly and by analytical studies see whether expenditures were properly or improperly made.

Operating reports of water works have been pretty generally standardized and in this respect present conditions are an improvement over those which existed in the past.

Standard Material

The standardization of materials and equipment used in water-works plants has been more or less considered for years past. We have at this time standard specifications for cast-iron pipe and fittings which are almost universally employed, and manufacturers thruout the country are enabled to carry a very much smaller stock of patterns with the assurance that they will meet the demands of nearly every community. Perhaps there is no more fruitful field for the judicious exercise of the principles of standardization than in water-supply matters. In nearly every section of this important branch of the public service there is something which could be improved and made more efficient by the adoption of a standard; for example, in the matter of hose and hydrant connections and fittings, in meters, and in the case of brass goods used for service connections. In some of these matters the question of standardization has been discussed. Committees have been formed by the water-works associations, and in some cases results have been obtained looking towards systematizing these goods.

One of the most important and heretofore most neglected of the above list is that of brass goods for service connections. The New England Water Works Association has formed a committee to consider the subject, but beyond that nothing has been done until very recently. The result has been a chaotic state of affairs. There is now, however, a growing tendency towards standardization in all water-works supplies and equipment, and the water works associations have been appointing committees for the purpose of developing standard goods which, of course, can be produced cheaper and will be more efficient in the end than the goods now used. There is room, however, for a considerable amount of work in this connection yet to be done.

Pumping Machinery

In no branch of water-works engineering have greater changes developed in the last few years than in the design and selection of pumping machinery. The first really successful water-works pump was the direct-acting steam pump. Henry R. Worthington, the father of the modern pumping engine, brought out the first of this type of pumps about 1840. The year 1895 marked the introduction of the duplex direct-acting pump and various improvements resulted from the efforts of such men as Blake, Knowles, Cameron, Marsh, Dean and others.

The use of steam pumps on a large scale began about the year 1860, and the crank and flywheel pump appeared about 1868. Various other improvements followed, which were principally improvements in details of the mechanism of the pump. No really fundamental change in design occurred until about 1876 when the Corliss pumping engine made its first appearance and proved to be a success. Steam was now being used expansively with a marked increase in economy. Duties by this time had risen from around 50 thousand foot-pounds per 1000 pounds of steam to around 120 thousand foot-pounds per 1000 pounds of steam. It was quite logical that the steam pump should follow step by step the development of the steam engine with corresponding improvements in economy.

All of the pumps up to fifteen or twenty years ago installed in water-works plants were of the reciprocating type, either direct-acting or crank-and-flywheel, either vertical or horizontal pumps as the case may be. The term "reciprocating pump" covers all pumps in which the water is displaced by a plunger, piston, or bucket, working back and forth in a cylinder. The past fifteen or twenty years marks the development of the centrifugal pump, altho in 1680 the first centrifugal pump was built, and 1818 was the year when the first crude pump of this type, called the Massachusetts pump, was built in this country. It is probable that the centrifugal pump did not come into general use because of the fact that it is a relatively high-speed machine and there was no motive power well suited to it, but with the introduction of the steam turbine and electric motor, conditions have changed. These high-speed machines stimulated the development of the centrifugal pump and we now find an ever increasing demand for this type of machinery.

Probably another reason for the delay in demand was due to the low efficiencies of the earlier types of centrifugal pumps, but at the present time turbine-driven centrifugal pumps of large capacity have been installed in water-works plants which have produced duties of from 135 to 165 million foot-pounds per 1000 pounds of steam as compared with 170 to 180 million for the best types of reciprocating engines.

When the low first cost of the turbine-driven centrifugal pump is taken into consideration, it makes a very attractive proposition for large water-works. In small isolated water-works the electrically driven centrifugal pump offers many inducements, and there are to be found now many installations of centrifugal pumps which are driven by producer-gas engines, oil engines of the Diesel type, and gasoline engines. The tendency towards centrifugal pumping machinery is notable and marks a step in the evolution of water-works design.

Rainfall and Runoff Records

The source of all water supplies, whether surface or underground, is the precipitation of vapor from the atmosphere commonly known as rain, but also in the frozen forms of snow, sleet and hail. These last are eventually reduced to water and the recorded quantities of snow, sleet and hail are expressed as equivalent water. Part of this precipitation is re-evaporated into the atmosphere. Another part falls directly on the water surface of lakes, swamps or streams. Some is transpired by vegetation and a portion runs off directly from the ground surface. The remainder enters the soil. Surface waters and subterranean waters feed the water courses at various distances from the point at which the rain falls.

All of these actions take place at irregular intervals varying in duration, and may be much extended, except that direct or surface runoff is generally limited to relatively brief periods, which vary with the topography, geology, geographical location and physical conditions of the watershed and its cover, as well as with the season and climate.

A knowledge of the amount of runoff in various localities and on various watersheds is absolutely essential to the proper design of dams and reservoirs. One of the great difficulties which the water-works engineer had to contend with in the past was the absence or paucity of suitable rainfall and runoff data. Great strides have been made in maintaining gaging stations for the purpose of recording the runoff of streams in various parts of the country. These have been of invaluable assistance in the proper and secure design of water works. Few people recognize the value of maintaining rainfall and runoff records. This Committee begs to call its importance to the attention of the municipal officials and to request that they encourage the maintenance of such records in the states in which they live, and to the water-works officials here present a request is made that they maintain such records on the watersheds under their jurisdiction and control.

Works for the Collection and Distribution of Water

No great changes have occurred in the design of structures for the collection of water, which include the dams and aqueducts, within recent years, except that concrete, as in every other line of engineering endeavor, has replaced other forms of masonry. Much more care, however, is exercised in the design of dams than was formerly the case, and a greater factor of safety is required than in times gone by. The failure of large dams in this country developed public opinion to a point where it demanded legislation requiring state supervision of dam construction and this has resulted in better design, workmanship and material.

Cast-iron is still the stable material for the fabricaiton of pipes for water distribution in cities and towns, altho wood-stave and wrought-iron and steel pipe are occasionally used in transmission lines. Great strides, however, have been made in the design of the details of the distribution system, including the design of hydrants, valves, corporation and curb cocks and the like, but probably the greatest strides have been made in labor-saving devices which have been developed for use in connection with the maintenance of the distribution system. The making of connections under pressure and the insertion of valves without cutting off the water, and other operations of like nature, have greatly facilitated the work of the water-works superintendent.

Because of the high price of iron and steel, the use of concrete, particularly for tower tanks and pipes, has increased. Some of these structures were poorly designed and built and discredited the material. However, refinements in the mixing and placing of concrete as well as greatly improved methods for making it impervious to water, have brought it into the reliable class.

For the past few years, maintenance and necessary extension only has been the motto of water authorities, but a period of more active construction is approaching rapidly. Work on the new supply for Providence has been resumed. Large purification projects are under way at Baltimore, Milwaukee, Cambridge, Kansas City, and Detroit, while in general the undone work of the war time is only awaiting a stabilized labor market for its doing.

Standards for Water Quality

Standards of quality are steadily rising and bid fair to continue doing so. Communities no longer consider safety sufficient, but demand a drinking water of good appearance. This demand has good scientific foundation, for the best appearing waters are frequently the safer.

In certain sections, the northeast particularly, waters having colors of 25 or more are still used without complaint. These colors would not be tolerated in western cities supplied with lake or filtered river water. Even in New England, public opinion is fast getting in a position to demand water of an average color of 10 parts per million or less, with a maximum of 15. Particular objection is made to colored surface waters containing odoriferous organisms, and turbidity, whether due to heavy microscopic growths, to clay, or to iron rust, is also objectionable.

While the bacteriological standard of the United States Public Health Service met with considerable criticism because of its alleged severity and because it excluded certain water supplying communities in which good public health conditions prevailed, it cannot be denied that those who are aiming to supply waters of high quality are trying to equal or better this standard which, as is well known, commands that all waters used in inter-state commerce shall contain no gas-forming organisms (presumably B. coli) in at least three out of five portions of 10 c.c. from the sample tested. One reason for this appreciation is the improvement in public health diagnosis; this, in turn, leads to better vital statistics, better organization of the health authorities and refinements in clinical methods.

Quite recently the significance of certain spore-forming bacteria (B. welchii, B. aerogenes and B. enteriditis), when found in water, has been the subject of much discussion especially in connection with the outbreaks of intestinal diseases other than typhoid fever, at Shreveport, La., and Montclair, N. J. These spore-forming organisms are more resistant to the action of chlorine than B. coli and other non-spore forming organisms and are apt to exist in surface waters which have been chlorinated but not otherwise purified or imperfectly purified by rapid filtration. Both the nature of these organisms and their relation to disease are as yet known imperfectly, and Sir Alexander Houston has recently expressed his opinion that the B. coli should still be regarded as the criterion for classifying waters with regard to their connection with gastro-intestinal disease.

Water Softening

Rain water, which is initially pure and soft, acquires mineral constituents as it percolates thru the soil, and the mineral content of water, therefore, depends upon the character of the soil and rocks thru which the water has percolated before it is tapped into the source of supply. Therefore, hard water is to be expected in countries where limestone, dolomite, sandstone, gypsum, and glacial deposits are found. From these and similar sources soft rain water is converted into more or less hard water. Hard waters are objectionable in many ways. For domestic and laundry use they require large quantities of soap. They are unsatisfactory for washing because they have a deleterious effect on the finer fabrics. They are unsatisfactory for bathing because they have an annoying effect on the skin. They increase plumbing bills because of the formation of scale in waterbacks and piping. For boiler use they cause trouble by forming scale in the boilers, which shortens the life of the boilers and fire boxes and increases the bills for fuel and repairs. In certain special industrial processes hard waters are considerably less satisfactory than soft waters, and they cannot be used in certain processes, such as bleaching and dyeing establishments.

It is likely, therefore, that the increasing competition for industrial growth and the rising standards for domestic water supplies will lead to a substantial growth in water softening. The need for water softening does not depend on sanitary grounds so much as on economic grounds. The hardness of the water has little or no effect upon the public health, but for both industrial and household uses hard water is unsatisfactory. In particular, the quality of a municipal water supply for industrial purposes assumes importance where towns are competing for the location of industrial plants. Many towns depend upon railroad shops and round houses, or large manufacturing plants, for a considerable proportion of their population. The progressive city with an ample supply of soft water will grow while others will stand still. There is a more direct economic appeal, however. Under certain conditions, depending upon the hardness of the water, the size of the town, and other local considerations, the residents of a town will save money by softening its water. The relation between the cost of water softening and the saving resulting therefrom to the ordinary householder is very direct, and in many cases the saving in soap alone is sufficient to pay for the cost of softening, to say nothing of the saving in damage to the finer fabrics, the reduced cost of plumbing, etc.

There is an increased demand for softened water, particularly in residential districts and in textile dye houses and bleacheries now supplied with hard water. In addition to the limesoda process in use for seventy years, artificial zeolites, of which "Permutit" and "Delcalco" are trade examples, have had widespread use in the industries, in hotels and large residences, and are beginning to enter the municipal field. By their use, water may be completely softened, the calcium and magnesium in the water exchanging with the sodium in the zeolite. After the zeolite becomes exhausted, it is regenerated by contact with brine, followed by washing with water.

Water Supply and Disease

Among the worthy accomplishments of the past decade has been the reduction in the typhoid-fever death-rate in American cities; another was the remarkably low typhoid death-rate among the American Expeditionary Forces, a marvelous contrast to the records of the Spanish and Boer Wars. For example, the typhoid death-rate of Massachusetts for 1920 was 2.5 per 100,000 and only five of the cities of that state had rates exceeding 5 per 100,000, a glaring contrast with conditions of fifteen years ago when leading sanitarians were talking of "residual" death-rates much higher than these actual accomplishments.

Nothwithstanding these improvements in the public health, due in largest measure to improvements in water supplies by storage, inspection, filtration and disinfection, the goal is not yet reached. Mild outbreaks of gastro-intestinal disease, like a mild type of dysentery, rarely causing death, appear suddenly in many municipalities, especially in the Spring, and the distribution of disease is such that the public water supply has seemed in each case to be the cause. The necessity for vigilance and study still exists and the well known lines of defense against water-borne disease must be well supported, for without watchfulness the best designed works may fail, as evidenced by the recent outbreak of typhoid at Salem, Ohio. Material assistance may be given to the water department by the community in destroying infectious material at its source, and by better use of the methods of hygiene and preventive medicine.

Water Purification

Both the advantages and limitations of storage as a method of purification have been the subject of recent discussions, the consensus of opinion being that it is a valuable and perhaps the most reliable single method, but not free from the danger of wilful or accidental contamination.

There have been few changes in the basic design of water-purification plants within the past ten or fifteen years, but many improvements have been made in the details of water-purification plants, particularly with respect to the pipe galleries in gravity mechanical plants, with respect to the handling and application of chemicals, and other practical matters. The use of the hydraulic jump to mix chemicals with water by J. W. Ellms, in the Milwaukee experiments, seems to be a simple and effective substitute for the older methods of baffled channels, agitators, weirs and other mixing devices.

Where filtration and softening are combined, difficulties resulting from the so-called balling-up of the filter sand, due to the accretion of lime deposits on the sand grains in the filter beds, are being overcome by several methods which have been developed recently, notably by the use of carbon dioxide gas at Defiance, O.

The knowledge of the handling and application of chemicals used in the treatment of water has been vastly benefited by the researches of physical chemists in recent years.

The difficulties of treating colored waters and waters of low alkalinity to produce an effluent free from color, turbidity and colloidal aluminum hydrate, and one which would not erode or corrode service pipes and plumbing, are well known. While many operators have surmounted the difficulties connected with the purification of such waters, they have done so by methods largely empirical; it was difficult to find a scientific basis for proper treatment or reasons for failure. Recently, however, water chemists have made use of the hydrogen ion concentration, and the method bids fair to explain much which is now obscure.

Briefly, the hydrogen ion concentration is a measure of the reaction of the water, of its acidity or alkalinity, but it is a delicate and discriminating measure and gives information which the ordinary alkalinity determination does not. By hydrogen ion concentration is meant the concentration of disassociated or active hydrogen in the water. The standard alkalinity determination measured the total amount of alkali present, but it did not measure the concentration, either before or at any stage in its neutralization. The determination of the hydrogen ion concentration gives by difference the concentration of the alkalinity at any time, and this is a factor that is often of very great importance to know and which may throw a great deal of light on proper application of chemicals in water purification plants. Your Committee will not attempt a technical discussion of hydrogen ion concentration at this point, but simply wishes to call attention to the benefits which may result from this method of measuring the re-action of the acidity or alkalinity of water.

Our more progressive officials are beginning to realize that water purification is not only a problem of hydraulics and mechanics, but a problem of chemistry and biology as well, and are giving more encouragement to laboratory work. It is unfortunate that very little attention has been given to the laboratories at water purification plants in the past. The larger plants have had well equipped laboratories from the beginning, and expert chemists and bacteriologists were employed to carry on the routine analyses necessary for the proper operation of such plants, but very few of the smaller plants maintained properly equipped laboratories and fewer still had anyone connected with the plants who had a fair knowledge of chemistry or bacteriology. This practice is fraught with much danger for the reason that the existence of a filter plant gives a feeling of security to a community, whereas a filter plant without proper supervision may be but a blind to camouflage a really critical situation.

Fortunately, however, at the present time boards of health in many cities, and particularly in many of the states, are taking a hand in the supervision of water purification. It has become necessary for the water departments to report to the health boards the result of their chemical and bacteriological analyses. This has resulted in the establishment of laboratories in nearly all except very small plants. Closer attention is given to the results obtained, for the health departments are also testing water. In some states the supervision of filter plants has gone so far as to require all operators to be licensed. The State of New Jersey, so far as this Committee knows, has been the pioneer in this respect. On February 9, 1918, an act was passed relative to the examination and licensing of operators. This act authorized the State Department of Health to examine prospective operators and to issue a license, providing the examination of the applicant proved him to be capable of performing those duties which would be required of him. It is further provided that every purification plant must have a licensed operator. This is a step in advance and should result in better filter-plant operation.

It is to be remembered, however, that the licensing of operators and the making of daily routine analyses are not all that is required. The water-works superintendent should give greater attention to the analysis of the water supply under his charge. Analyses are useless unless used, and this observation is true with regard to all operating data in a water-works plant. The mere collection of the data is not sufficient. They must be used and applied.

Electrolysis

Ever since the advent of the street railway, water-works plants thruout the country have complained of electrolysis of mains and service pipes. The term "electrolysis" embraces the entire process of accelerated corrosion of underground metallic structures due to stray currents.

The practical electrolysis problem is due to stray currents from electric street railways. Instances of stray currents from other sources sometimes occur, but such cases are rare and are not specifically considered.

Electric currents straying to earth from electric tracks frequently find their way to water and gas pipes, telephone and power cables, and other underground structures. When this current leaves these structures thru earth, corrosion results. Thus not only are the structures of many different companies subject to injury, but by reason of the different public services dependent on such structures, the public as a whole has a direct interest in this type of electrical interference.

As the investment in pipes and service connections in the towns and cities of this country is enormous, the added depreciation resulting from electrolytic corrosion represents a large economic loss to the municipalities of the country. Suits were brought in several instances to compel the street railway companies to modify or change their system of operation or to secure damages for electric corrosion. No definite beneficial results were obtained from these suits for the reason that the data were not sufficient on which to base a determination of the minimum residual amount of stray current which was permissible and which would not cause injury to underground metallic structures nor whether it was feasible for the street railways to keep the stray current down to this minimum residual.

Believing that the matter was subject to co-operative treatment the American Committee on Electrolysis was appointed. This Committee consisted of representatives of the electric railway, electric light, telephone, gas and water interests. Already one report has been made on the subject of electrolysis and a second report will be issued within a short time. It is to be hoped that this Committee will be continued and that the results of its work will be to bring about a better understanding of the problem of electrolysis prevention and a closer co-operation between the electric interests and the interests which maintain the structures affected by electrolysis.

It has been found advantageous to form joint committees composed of technical representatives of the several utilities concerned to investigate the local electrolysis situation and determine by agreement the course of procedure to be followed. Such committees should, of course, attack the problem in an open and fair minded manner with the object to effecting mitigation in the most economical way. To this end they should be composed of men, or have men associated with them, who are trained in the technique of electrolysis. Active committees of the kind described are now existent in Chicago, Kansas City, Omaha, St. Paul, New Haven, Milwaukee and Syracuse. The principle of co-operation has been recognized by the Railroad Commission of Wisconsin in an order authorizing an electrolysis committee in the State of Wisconsin. Such committees act as clearing houses of information and keep all of the interested companies informed as to changes in their systems which may affect the electrolysis situation. Under the direction of such a committee joint electrolysis surveys may be conducted and unified methods of mitigation installed and maintained.

DISCUSSION

A MEMBER: Do you advocate electrically driven pumps or steam?

MR. HILL: They are used in various combinations. There is the electrically driven centrifugal pump, which lends itself to smaller water works. Then there is the steam-driven turbine pump, used in the larger units, and gas engine and gasoline engine driving centrifugal pumps and engines of the Diesel oil type are also used, so that the drive is varied.

WATER SUPPLY OF BALTIMORE

By V. Bernard Siems, Associate Civil Engineer Water Department

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History of the Water-Works of Baltimore

In the early years of its history Baltimore abounded in many springs of pure and excellent water, but as the community increased, these either disappeared or became contaminated to such an extent as to render other supplies imperative. The first attempt to establish a water company was made in 1787, but abandoned thru lack of interest. In 1792 an act was passed by the Maryland Legislature authorizing the Baltimore Water Company to supply water to property owners in the city, but this also failed to materialize. After the incorporation of the city in 1796, the City Council recognized the necessity of an adequate water supply and appropriated $1,000.00 to erect and maintain pumps in streets. In 1799 a commission was created to examine the adjacent streams and, altho recommendations were made, the project was alternately discussed and discarded until 1803.

Recognizing the inability of the city government to meet the situation a public meeting was held to organize a stock company to furnish the city with water, money being secured thru the efforts of the insurance companies and other public institutions. Work was begun in the valley of Jones Falls, the pumping station being located at the present corner of Calvert and Franklin Streets, pumping to a reservoir at Cathedral and Franklin Streets. The plant was in successful operation in May 1807. Negotiations were then begun for the purchase of the company and continued, intermittently, until August 1854, when the entire properties were deeded to the City for the sum of $1,350,000.00. The sale embraced not only the water-works proper, but much valuable real estate purchased by the company in the course of expansion. At the date of sale, the entire plant consisted of two small pools of water formed by the dams of the Mount Royal and the Rock Mills, having a capacity of 10,000,000 gallons, from which the water was conducted thru large iron mains into a receiving reservoir on the east bank of the Falls below Charles Street bridge. This reservoir fed by gravity all points below an elevation of sixty feet above mean tide. For higher localities, the water was pumped into a second reservoir at Charles and Chase Streets, which fed all points not exceeding 136 feet above mean tide. The joint capacity of the two reservoirs was only 25,000,000 gallons. The distribution mains were of cast-iron and about fifty miles in extent.

With the acquisition of the water company, a water department with a board of three commissioners was created. Realizing the need of an improved supply, a survey of the available streams about the city was made, but nothing definite accomplished until 1857, when the Jones Falls was selected, despite the advantages offered by the Gunpowder River. Work was begun on a dam across a narrow pass in the valley about eight miles from the city; the dam and Lake Roland being completed in 1861. Hampden and Mount Royal reservoirs were completed in 1862, serving high and low services, respectively.

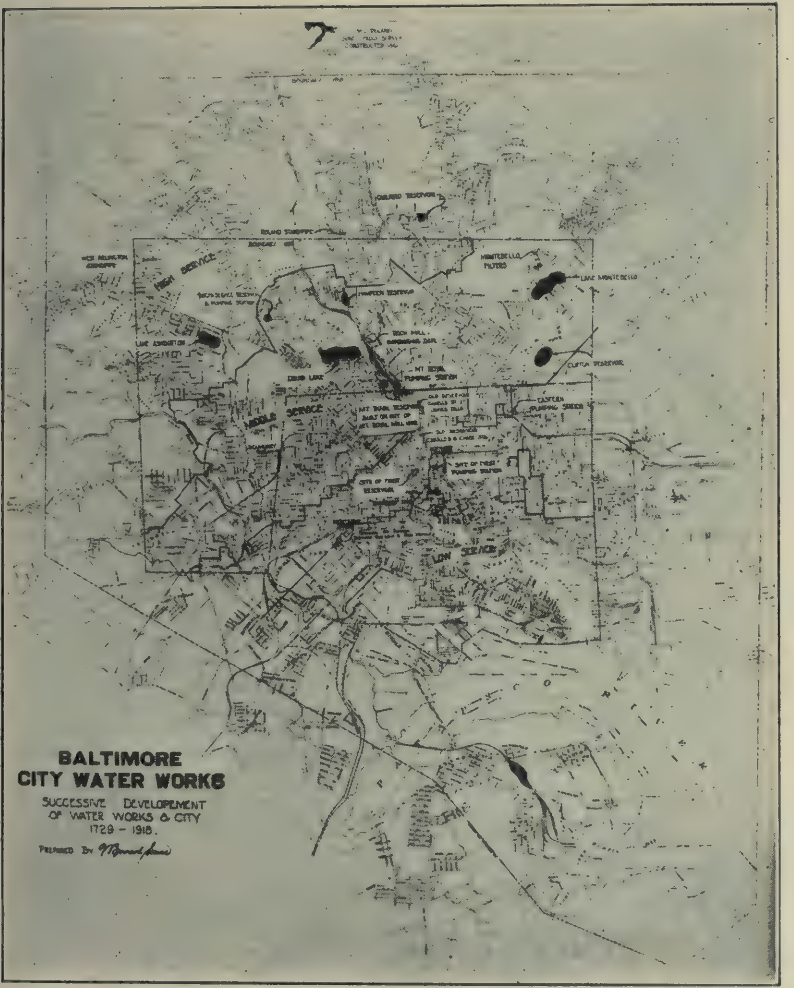


Fig. 1. Map Showing Growth of Baltimore City Water Works

Druid Lake, started in 1863 and completed five years later, supplied middle service in addition to Hampden Lake, which formerly maintained high service. High service reservoir, built in 1874, was designed to supply old high service, but is now used as suction for Druid pumping station, which pumps to the standpipes feeding present high service.

In 1872 the inadequacy of the Jones Falls supply was apparent and a temporary supply was secured from the Gunpowder River by pumping over the dividing ridge between the Gunpowder River and Jones Falls into Lake Roland, five million gallons per day being supplied in this manner.

In 1874, $4,000,000.00 was appropriated to complete the Gunpowder supply, the following works being necessary:

The construction of Lake Montebello, covering an area of sixty acres with a capacity of 500,000,000 gallons; the construction of an impounding dam at Loch Raven with a crest elevation of 170 feet above mean tide and a reserve capacity of 510,000,000 gallons; a tunnel 12 feet in diameter and 7 miles long connecting the impounding reservoir with Lake Montebello and capable of delivering 170,000,000 gallons per day; the construction of Lake Clifton as a storage reservoir with a capacity of 265,000,000 gallons and the laying of 40-inch main from Lake Clifton to the city limits.

In 1881, under normal conditions, about three-eighths of the city's water supply was received from Jones Falls; the new Gunpowder supply furnishing the remainder.

As early as 1907 the Health Department announced that the typhoid cases in the city were due to the water supply. In 1911 purification was begun by treating the water with calcium hypochloride; this being followed by a marked reduction in typhoid cases.

The growing dissatisfaction with the water supply led, in 1908, to the floating of a bond issue of $5,000,000.00 to increase the water supply. With this appropriation the following improvements were carried out:

A new dam some 2400 feet above the old dam, designed for crest elevation of 235 and only carried to an elevation of 188 feet above mean tide; the erection of a filtration plant near Lake Montebello with a covered reservoir for the filtered water, to supply the combination of old low and old middle services; and the construction of Lake Ashburton in the northwestern section of the city to supply the western middle service zone.

This brings the Baltimore city water department to the present day. The Jones Falls supply has been abandoned, but can be used to supply unfiltered water when an emergency arises, lime and iron being applied at the Roland gatehouse. All the water is now supplied by the Gunpowder River, flows to the Montebello filters, is filtered and stored underground, then flowing by gravity to low service, feeds all sections of the city under a contour of 100 feet above mean tide, and supplies the pumping stations for eastern and western middle services.

The eastern middle service is supplied by the eastern pumping station, located on Oliver Street west of Wolfe Street. This station was built in 1889-90 as a steam-driven plant, but converted in 1915, when a motor-driven Westinghouse-Cameron centrifugal pump was installed.

The electric energy for the station is supplied from an outside source at 13,000 volts, 3-phase, 25-cycle, transformed within the building to 550-volts, at which pressure it is supplied to a 800-h.p. motor directly connected to the centrifugal pump.

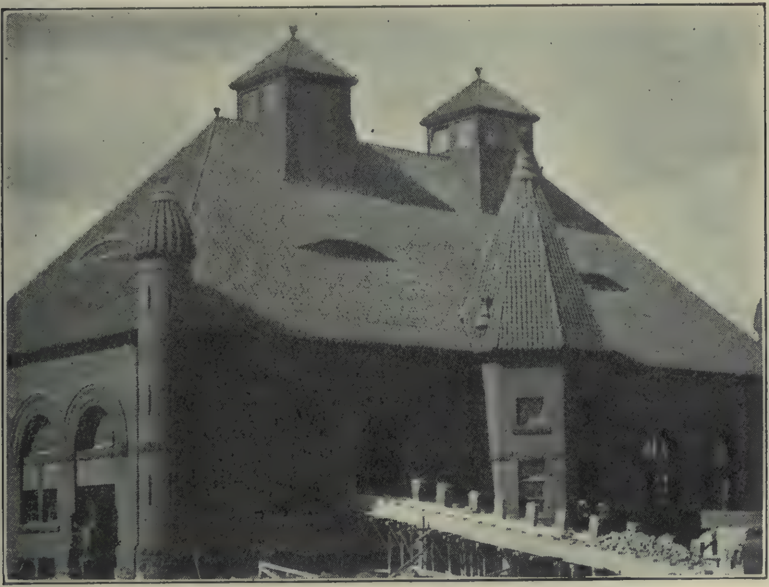


Fig. 2. Eastern Electric Pumping Station: Cost of Pumping $11.37 per M. G.

The pump is of the single stage, double suction type; suction line connects directly to the distribution manifold of the Montebello filtered water supply in Clifton gatehouse, the discharge feeding Guilford reservoir. The pump operates at a synchronous speed of 750 r.p.m., delivering 20,000,000 gallons daily, the discharge being measured by a Builders Iron Foundry Venturi meter installed in the suction line.

In 1921 a contract was awarded for a second 20,000,000 gallon pump and motor similar to the original installation. This will be a Westinghouse-DeLaval unit, and will be in operation about October 25, 1921.

The eastern pumping station is provided with a motor-generator set which operates the motorized tools of the machine shop and supplies light for the buildings and the grounds at the Gay Street Yard. The transformers, likewise, supply current for a 25 h.p. motor which drives the line shafting in the machine shop.

Mount Royal Pumping Station:

The Mount Royal pumping station, located at North Avenue and McMechen Street and built in 1899, maintains the western middle service. It is the one remaining steam operated plant.

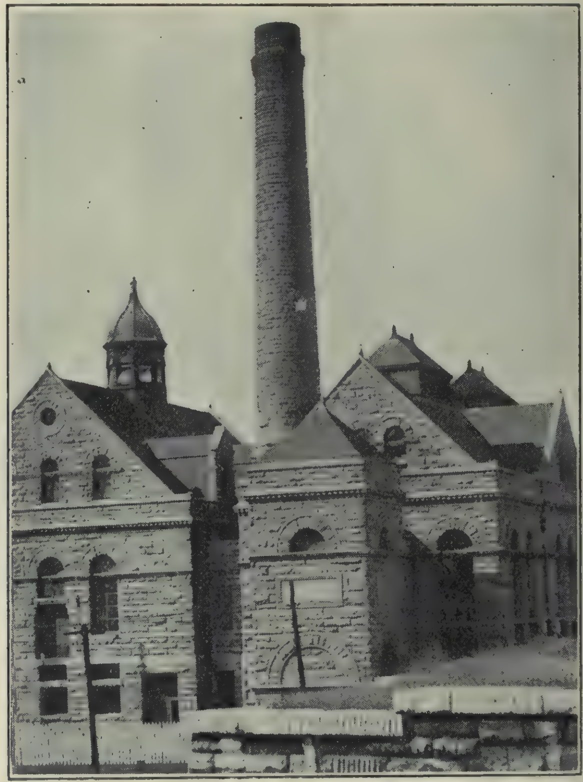


Fig. 3. Mt. Royal Steam Pumping Station: Cost of Pumping $14.22 per M. G.

The boiler plant consists of four 200-h.p. Babcock and Wilcox boilers fitted with Taylor underfeed stokers, with automatically controlled forced draft. The coal is handled by the Hunt system and stored in overhead bunkers of 1800 tons capacity. The ashes are also handled by the coal conveyors and stored in an outside bin arranged to discharge either into cars on the spur track or motor trucks in the roadway.

The pumping equipment consists of one Worthington horizontal triple-expansion compound plunger pump of 17.5 million gallons daily capacity, installed about 1900; one Bethlehem triple-expansion vertical crank-and-flywheel plunger pump of 30 million gallons daily capacity, installed in 1912 and one General Electric-Worthington turbo-centrifugal pump of 30 million gallons daily capacity, installed in 1920. The suction of these pumps is taken from the manifold of the Montebello filtered water supply in Clifton gatehouse and the discharge main supplies Lake Ashburton and the high service suction reservoir in Druid Hill Park. The elevation of the three lakes supplied by the middle service pumping stations is 350 feet above mean tide; the water flowing into middle service embracing all territory between contours 100 and 250. The output of the station is measured by a Builders Iron Foundry Venturi meter located in the suction line.

Fig. 4. High-Service Electric Pumping Station: Cost of Pumping, $28.94 per M. G.

The engine room is provided with a crane of ample capacity for handling the machinery, and also contains two Turbo generators and control equipment for supplying the light and power needs of the plant.

High Service Pumping Station:

The eastern and western high service is supplied by the high-service pumping station adjacent to the high-service suction reservoir in Druid Hill Park. This station was built in 1914-15 and is provided with two Westinghouse-Wood motor-driven centrifugal pumps on the western high-service side and three pumps of similar type on the eastern high-service side.

The current for the station is supplied from an outside source at 13,000-volts, 3-phase, 25-cycle, and is transformed by a substation to 550-volts for the motors. The western high-service equipment consists of 5,000,000-gallons daily capacity, single-stage, double-suction centrifugal pumps directly connected to 200-h.p. motors; the eastern high-service side is provided with 2,000,000-gallons daily capacity single-stage, double-suction, centrifugal pumps directly connected to 75-h.p. motors. All this equipment is controlled by an automatic switchboard, so devised as to start and stop the pumps according to the water level in the West Arlington and Roland standpipes. This, however, has never been placed in continuous service, the stations being manually controlled. Two of the pumps on the eastern high service side are so arranged that they can be operated in series and supply western high service in cases of emergency.

The pumps take their suction from the high-service suction reservoir; the western high-service pumps discharging into the West Arlington Standpipe; the eastern high-service into the Roland Standpipe. West Arlington Standpipe has an overflow elevation of 550 and Roland an elevation of 450 above mean tide. The West Arlington standpipe feeds all the territory in the eastern high service above contour 250. The consumption of each of these services is measured by two simplex Venturi meters located in the respective discharge lines. The station is equipped with a crane and other modern auxiliaries.

Construction of Additional Pumping Stations for Greater Baltimore:

The construction of eastern and western high-service reservoirs will necessitate the erection of two pumping stations to supply water to these reservoirs. Eastern high service will be maintained by a pumping station to be located at Montebello, taking suction from the clear water basin of the filtration plant and discharging thru a 36-inch water main to the reservoir. The western high-service pumping station, to be located at Lake Ashburton, will supply western high-service reservoir thru a 36-inch water main, suction to be taken from the adjoining lake.

As a temporary expedient and as a matter of economy prior to the construction of eastern high-service reservoir, a booster pumping station is to be erected at Belair Road and Franklin Avenue, pumping thru present and proposed water mains to Towson reservoir, to augment the Baltimore County Water and Electric Company's water supply at Towson and to supply the eastern high-service territory of our distribution system in the vicinity of Harford and Belair Roads, north of Franklin Avenue.

Middle-Service Pumping Station:

The consensus of opinion of water-works engineers is, that it is advisable to locate all pumping stations as near as possible to reservoirs. Accordingly, a middle service pumping station may be constructed at the Montebello filtration plant, taking suction from the clear water basin and pumping thru proposed mains to Guilford Reservoir, to supply eastern middle service. The present eastern middle service pumping station, at Wolfe and

Oliver Streets, would then be abandoned. With the construction of this pumping station at Montebello, all plants would be located in the vicinity of reservoirs.

Distribution System

Due to the difference in elevation between the various sections of the city, it has been necessary to divide the water distribution system into three zones; namely, low service, middle service and high service zones.

The low-service zone, which includes all the territory below the 100-foot contour, is supplied by gravity from the filtered water reservoir (elevation W. S. 213) at the Montebello filtration plant. This gives a static pressure of 213 feet or 92 pounds at the lowest points and 113 feet or 49 pounds at the highest locations. The total area covered by this zone of the distribution system within the 1888 boundary line, was 12.41 square miles, but with the territory annexed in 1918, the ultimate area will be 31.17 square miles, a small percentage of which will be supplied by private water companies. The low service maintains a portion of the residential and the industrial and commercial sections of the city, accounting for about 65% of the total water consumed.

Middle service zone is sub-divided into parts, known as eastern middle and western middle. Eastern middle, which includes all that territory east of the Jones Falls valley between elevations 100 and 250 feet, is supplied from Guilford reservoir at water surface elevation 340 feet. This gives a static pressure ranging from 240 feet or 102 pounds to 90 feet or 39 pounds. Western middle includes all the territory west of the Jones Falls valley between elevations 100 and 300 feet and is supplied from Ashburton Reservoir at elevation 350 feet. This gives a static pressure ranging between 250 feet or 108 pounds and 50 feet or 22 pounds.

The total area of the middle service within the 1888 Boundary Line is 13.10 square miles, but will eventually cover 20.30 square miles within the 1918 boundaries.

The water consumed in this zone is about 32% of the total consumption of the City.

The high-service zone is sub-divided into eastern high service and western high service. Eastern high-service zone includes all territory east of Jones Falls valley between elevation 250 and 350 feet and is supplied by the Roland standpipe at water-surface elevation 450 feet. This gives a static pressure ranging between 200 feet or 86 pounds and 100 feet or 43 pounds. The western high-service zone, which includes all the territory west of the Jones Falls valley between elevation 300 and 400 feet is supplied from Arlington standpipe at elevation 550 feet. This gives a static pressure varying from 150 feet or 65 pounds to 250 feet or 100 pounds. The present area of the distribution system in this zone within the 1888 Boundary line is 5.7 square miles, and as the ultimate area will be 31.03 square miles within the 1918 boundary lines, the plans of the Department provide for the construction of a reservoir at elevation 565 feet or 575 feet to supply western high service and a reservoir at elevation 465 feet or 500 feet to supply eastern high service. High service accounts for about 3% of the total consumption of the city.

Private Water Companies

There are ten privately owned water companies now operating wholly or in part within the newly annexed territory.

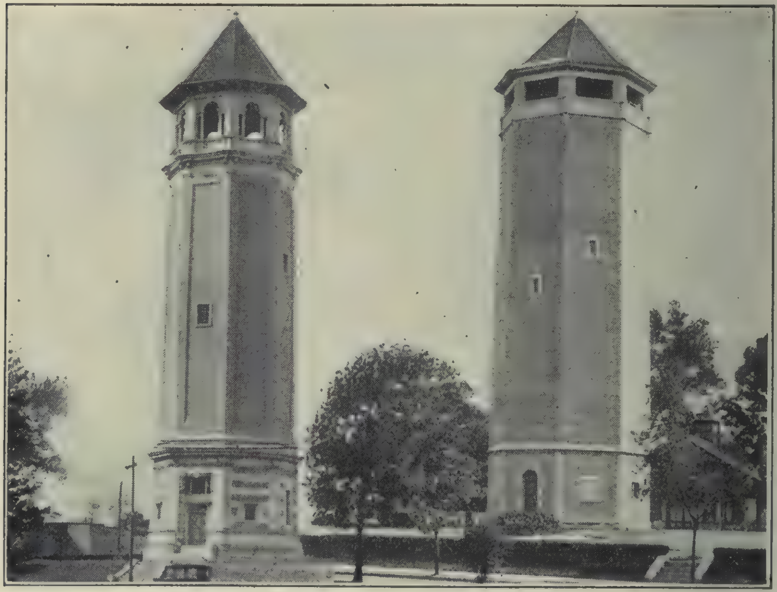


Fig. 5. Roland Standpipe   *Fig. 6. West Arlington Standpipe*

At the present time these companies are supplying water to approximately 70,000 to 75,000 persons, delivering from 7,000,000 to 10,000,000 gallons per day, of which amount the Baltimore County Water & Electric Company is supplying from 5,000,000 to 6,500,000 gallons per day. Several of the companies have been acquired by the city, the remaining ones to be purchased in the near future and their water distribution systems connected to the distribution system of the city.

Additions to the Distribution System

In order to supply the newly annexed territory of the city with water and to strengthen the present distribution system, it will be necessary for the Department to instal the following large mains in the immediate future:

Low service—60-inch—17,000 feet; 48-inch—3,000 feet; 42-inch—37,000 feet; 30-inch—45,000 feet.

Middle Service—30-inch—20,000 feet.

High Service—36-inch—50,000 feet.

Numerous other installations will be made, in addition to these mains.

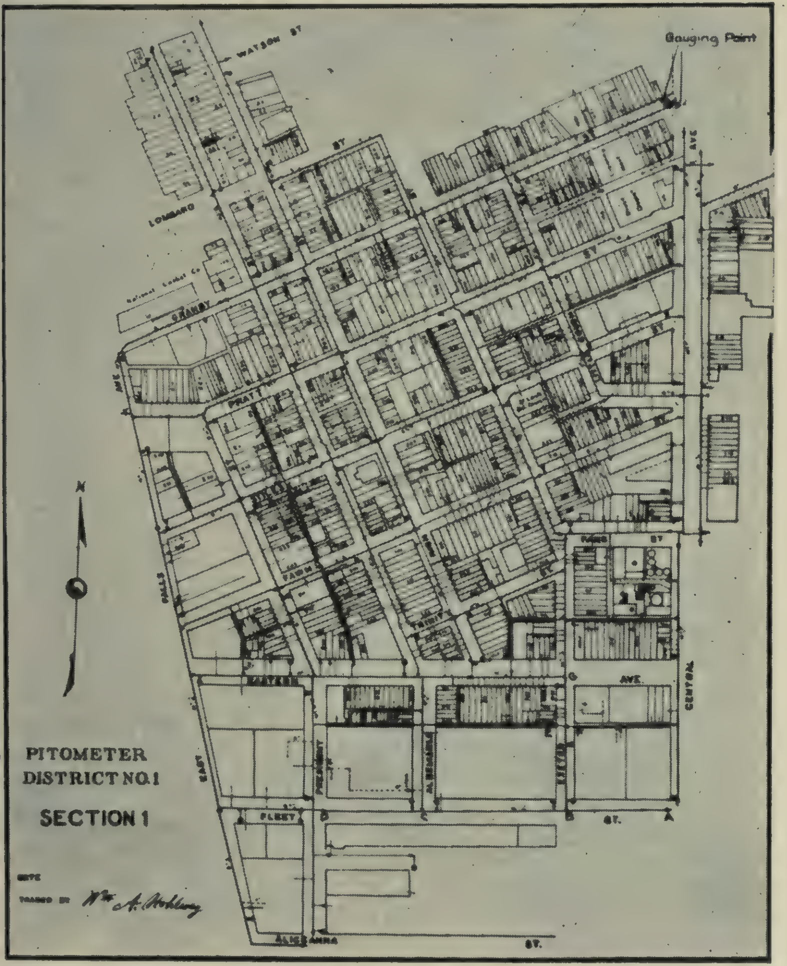


Fig. 7. Detail Map of Pitometer Survey of District No. 1

Conservation

Conservation work is being carried on for the prevention and discovery of water waste; the methods used being a pitometer survey, house to house inspection of all plumbing fixtures, the testing of all water mains and water supply services previous to the laying of improved paving, and other subsidiary preventatives.

Altho pitometer surveys were made in Baltimore some years ago, surveys on the present large scale were not begun until 1920. Doubtless everyone is familiar with the details of a pitometer survey, being briefly as follows:

The section to be measured is shut off by closing the valve bounding the district selected, leaving one main to act as a feeder into the section. This main is tapped and a Pitot rod inserted, the flow being measured by the deflection produced in a U-tube, which in turn registers on sensitized paper. The amount of water passing into the district is then calculated by considering the deflection produced and the pipe coefficient, which is secured by traversing the main. The initial measurement is made by running a twenty-four-hour record and during the same time reading all meters over 1½-inch, thus accounting for commercial consumption. After securing the gross consumption of the section, sub-division is begun, being a breaking up of the district into smaller sections, so as to isolate each block one by one. To measure Fleet Street, for instance, between President Street and Central Avenue, valves B, C and D are closed which, with valve A closed, as are other boundary valves, shuts the main being measured out of water. If water is being consumed, either legitimately or thru leakage, there will be a drop in the water registered as flowing into the large district, of which this section was a part. Valve A is then raised and the stretch of main is re-established by means of water flowing from the outside system through valve A. To measure Exeter Street between Fleet Street and Eastern Avenue, valves E, F and G are then closed, followed by the opening of B, and so forth; this process being continued until a reading is made on every section of main.

Since the beginning of the present pitometer survey in July, 1920, the total amount of water saved in all the districts surveyed to date is about five million gallons per day or about six per cent of the total consumption of the city, the area measured accounting for about 25 per cent of the total consumption. This decrease in consumption, as registered by the pitometer instruments, has been more than substantiated by the records of the filtration plant.

The cost of the survey to date is $20,000, including the cost of repairing valves and other incidental maintenance work. The value of the water saved is, at current meter rates, $425.51 per day or $155,576.15 per year.

Approximately 10 per cent of the mains of the city supplying about 12 per cent of the population and covering about 10 per cent of the area of the city have been measured.

House Inspection:

House inspection has been carried on in Baltimore for several years, tho never on such an extensive scale as at the present time, when an average of sixteen women are employed as house inspectresses. All plumbing fixtures are inspected, aquaphones being used to detect invisible leaks, notices to have the plumbing repaired being served, when necessary, upon the property owners. Upon the expiration of seven days the property is re-inspected and if plumbing is not repaired, depending upon the size of the leak, orders are issued to have the water turned off. In conjunction with the inspectresses, two men are employed to re-inspect and re-serve leak notices, with four men to turn off the services.

In 1919 a force of six inspectresses found 17,449 leaking fixtures during a survey which covered not quite the entire city. In 1920 eighteen inspectresses covered the entire city twice; locating only 28,227 leaks of which 1,633 or about 5% were turned off because of non-compliance with the notice to repair. It is estimated that the house inspection has resulted in a saving of 5,000,000 gallons of water per day.

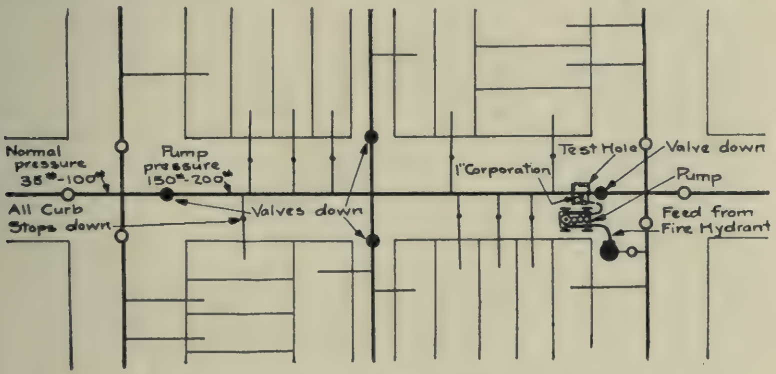


Fig. 8. Layout of Pressure Test of Water Main

Testing Work:

Water mains in public highways and alleys to be improved are overhauled and tested, that is, all curb stops, curb-stop boxes, valves, etc., are examined and when necessary, cleaned, reset or replaced. All mains and water supply services, as far as the curb stop, are subjected to a pressure of three times the normal static pressure. The general arrangement is seen. A small gasoline-driven pump mounted on a trailer is used, being taken from place to place by the same truck to haul material to the foremen testing. This work is done under the supervision of a subordinate engineer. During the past year approximately 5,000 services and 20 miles of main were overhauled; the mains tested varying in size from 2 to 16 inches.

All water meters are tested by the Department before installation, a shop equipped for the testing, repairing and overhauling of meters, being located at the Gay Street yard, together with a modern machine shop.

Electrolysis:

While no consistent electrolysis survey of the city is being carried on at the present time, much experimental work has been done in connection with the destruction of water services in various sections of the city.

The Water Department is, at present, co-operating with the Bureau of Standards in field tests on a new type of measuring instrument, which when perfected will mark a new departure in the measurement of stray currents. It is expected that a survey will be instituted during the coming year.

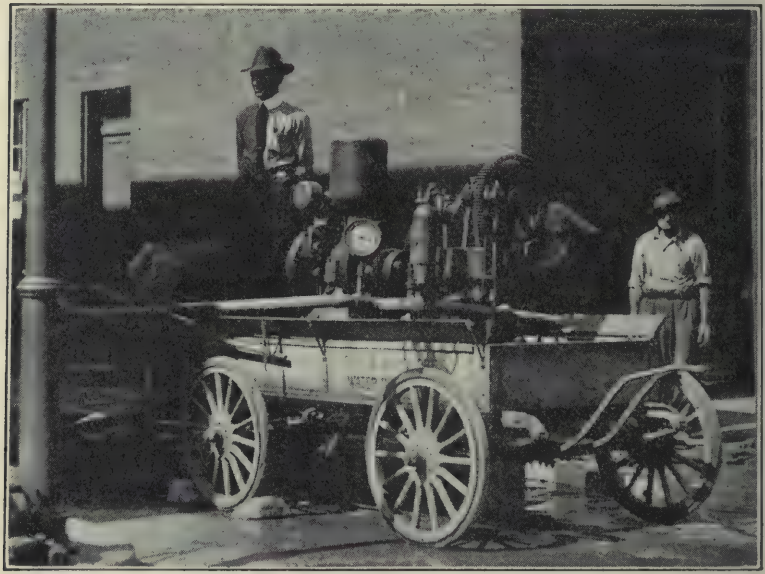


Fig. 9. Pressure Testing Outfit

Miscellaneous:

Among other work carried on is the inspection of all hydrants used thruout the city, the inspection of and recommendation for alleviation of slack supplies, the inspection of fire supplies, the approval of service applications, the maintenance of a pressure survey and the measuring and recording of water supply pipes.

Maintenance

Maintenance of the distribution system covers repairs to meters, valves, mains and fire hydrants and the repair and installation of water-service pipes. Some minor construction work is carried on, such as the connection of dead-end mains, the installation of fire hydrants and the elimination of deteriorated private-alley mains.

An electric thawing machine is used for relieving frozen water pipes. The Department will soon acquire a truck equipped with a valve-operating device, a pipe cutting machine and a centrifugal pump; thus forming a power-operated unit designed to meet all requirements of the repair corps. A force of from 12 to 15 gangs is employed, the field work being under the supervision of a subordinate engineer.

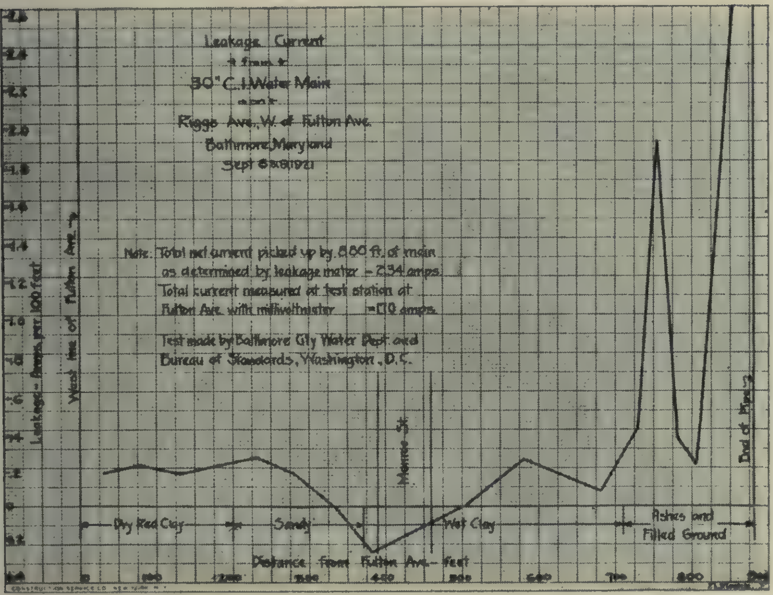


Fig. 10. Record of Electric Current Picked up by Water Main

Construction

Water-mains, water-supply services, valves and fire hydrants are now being installed in the territory recently annexed and not previously served with city water, together with work occasioned by the intensive development of the numerous suburbs about the city. Wherever feasible, the distribution system is being strengthened by the renewal of water-service supply pipes; the installation of larger water-mains in public highways about to be improved; and by the elimination of deteriorated mains in private alleys; most types of construction work, ranging from the laying of six-inch main to the installation of sixty-inch feeder mains and the construction of concrete conduits being done.

Mechanical labor-saving equipment is used wherever possible, the department using in its work three trench-excavators, a 5-ton crane, five large air-compressors, a concrete mixer, an air piling-hammer, 12 gasoline pumps, two backfillers and numerous pneumatic tools.

It is interesting to note that upon a large construction work at North Avenue and Oak Street the oxy-acetylene flame was used to burn out the joints and cut a 60-inch cast-iron pipe while in position. This work required about four hours as compared with the labor of eight men working sixteen hours.

Design

A concise detailed plan of the water distribution system for greater Baltimore has been made, showing all water-mains from 8-inch to 60-inch in diameter, in the three distribution zones.

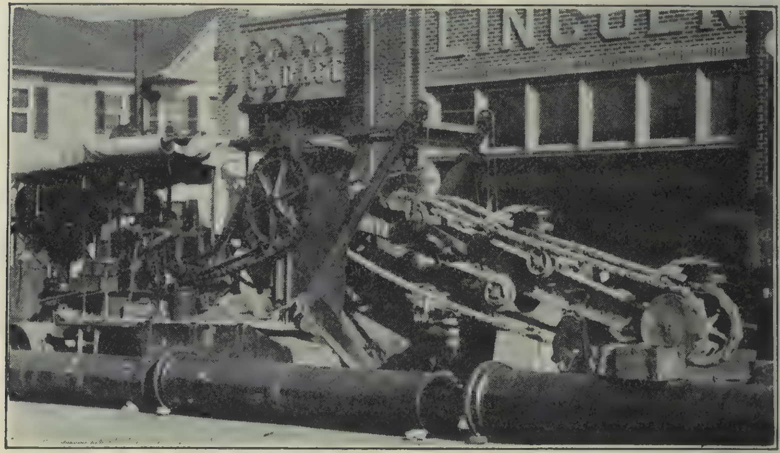


Fig. 11. Trench Excavator

It will thus be possible in the future, to extend water mains and to supply consumers in conformity with a layout that will eventually, adequately serve the entire new city.

Due acknowledgment is hereby made to the Water Engineer and the various assistant engineers of the writer, for the data furnished and to Mr. W. Lothar Eisert for the compilation of this paper.

DISCUSSION

A MEMBER: What is your experience as to interruptions on your motor-driven centrifugals?

MR. SIEMS: Our only interruption has been the current going off the electric motor, but no interruptions with the steam-driven turbine pumps.

A MEMBER: You lead your joints?

MR. SIEMS: Yes. We found air calking tools more expense than hand calking but we get a more uniform hammer blow and we have little difficulty with our joints.

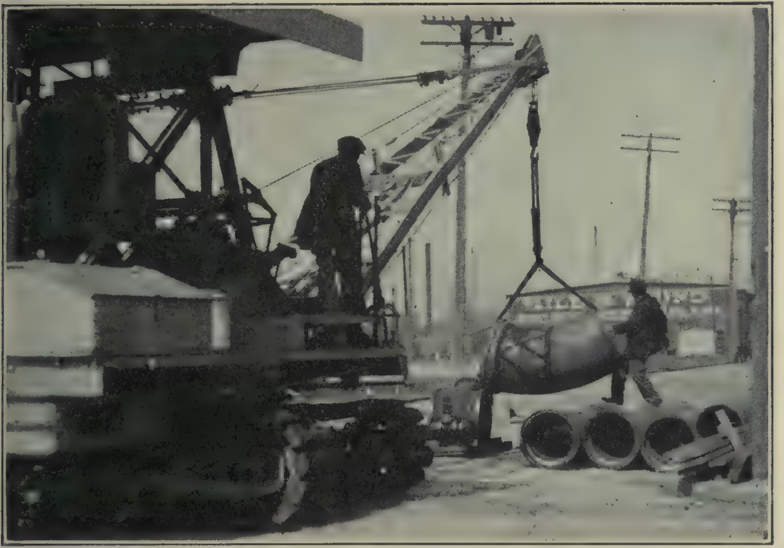


Fig. 12. Crane for Handling Pipe and Fittings

MAINTENANCE AND RESTORATION OF THE PURITY OF THE WATER SUPPLY OF BALTIMORE

By James W. Armstrong, Filtration Engineer

Baltimore is at present dependent for its water supply upon the Gunpowder River, a relatively small stream, whose flow is sometimes less than the city's requirements for water, but from a sanitary point of view it is more fortunate than many cities, whose supply is taken from streams too large to warrant any kind of sanitary control.

Water Shed Control

The Gunpowder watershed comprising 306 square miles lies almost wholly within Baltimore County, Maryland, only a small area near its source lying in Pennsylvania. It is thus possible to have under fairly close supervision the activities of the entire watershed, and to control absolutely all streams for a considerable distance above the city. The department believes that, as far as possible, it should control its entire water supply from the time it is given up by the clouds until it is drawn from the pipes for use.

Obviously complete control in a thickly settled area is not possible, but very much has been done in the past few years to prevent contamination of the city's water supply. First; by the purchase of land along the streams. The city now owns between two and three thousand acres of land, and when the new improvements are completed will own five thousand or more acres, and will have absolute control of both banks of the river as far north as Phoenix, which lies about 19 miles north of Baltimore. Second; by moral suasion, an effective method of water purification not usually described in technical papers but, nevertheless, one that should receive more attention from those in charge of the water supply of cities.

For years Baltimore has had an inspector who has systematically visited every premise on the watershed, and by good natured persistence has been the means of getting rid of the worst sources of pollution. His policy has been to lay before the people the importance of a pure water supply. Most of them see the point, and many have been willing to spend a considerable amount of money to eliminate sources of pollution. Probably the most effective work has been done in supervising and preventing the spread of typhoid fever. Every case is reported by the State Board of Health to the Department, and the inspector at once visits the premises to see that there is no possibility of contaminating the water supply. The necessary sanitary instructions for care of the patient are given, and disinfectants are supplied.

The inspector does not drop the case with a single visit but follows it to a conclusion. In this way everything possible is done to free the water supply from a suspicion of typhoid.

Forestation

Baltimore County is full of hills. Many of them are covered with clay which at times of heavy freshets is washed into the river, making the water very turbid. On one occasion it reached Montebello filters with a turbidity of over 5000, and it frequently exceeds 1000. Such water is difficult and costly to treat.

In order to prevent the washing of the soil and to retain as much water in the earth as possible, the Department aims to cover all ground with grass or timber. They have already planted over a million trees, mostly white pine and spruce, and as soon as the new improvements are completed, they propose to continue the plantings over most of the ground owned by the city.

Need of Greater Supply

During the year of 1910 there were six consecutive months when the flow of the Gunpowder River was less than 75 million gallons per day, and there was one month when it dropped as low as 54 million gallons per day. The recurrence of such a condition at the present, when the daily consumption is between 90 and 100 million gallons, would prove a calamity to the city, as it is not possible on account of the extremely high suction lift imposed upon the pumps, to withdraw water much below the existing level.

For a number of years the engineers of the water department have had a very keen realization of the situation confronting the city, and in their effort to find a solution of the problem, have investigated every source from the Susquehanna to the Potomac.

It seemed best to develop the Gunpowder River, the existing source of supply, to its ultimate possibility before going to other sources. Accordingly, it was planned to create a large impounding reservoir at Loch Raven by raising the existing dam from elevation 188 to 240, a distance of 52 feet. Raising Loch Raven reservoir 52 feet would permit Montebello filters to be fed by gravity, but in order to do so, the existing tunnel would have to be relined or a new one built.

In order to use the existing tunnel and pumping station, a plan was adopted of building a balancing reservoir near Loch Raven, which increased the head on the tunnel about 8 feet, and offers a satisfactory means of equalizing the flow of water admitted from Loch Raven. This work is now under construction, and will cost at contract prices based upon estimated quantities about $50,000.00.

Loch Raven Dam

The first step toward carrying out the improvements was taken in March, 1921, when a contract was awarded for the raising of Loch Raven Dam 52 feet. Fortunately, the old dam had been built with foundations fully able to carry the new structure. When completed, the new dam will have an over-all length of 637 feet, an ogee spillway section 288 feet long, and will contain about 40,000 cubic yards of concrete. The gravity type of dam was selected instead of the hollow or Ambursen type, as offering greater security against the action of frost and ice, extending over a long term of years, and as providing a better means of raising to a higher elevation at some future date.

A feature that complicated construction was the necessity of providing an additional gate chamber as a terminal for a new tunnel, which it will be necessary to build before Montebello filters can be fed by gravity.

Impounding Reservoir

The raising of Loch Raven Dam will form a reservoir covering an area of 2390 acres, and having a capacity of about 23 billion gallons. It will extend north as far as Phoenix, and will necessitate abandoning the cotton mills at that place. It will practically wipe out the picturesque village of Warren, and the mills of the Warren Manufacturing Company.

About six miles of county road and 2 or 3 large highway bridges will have to be built in order to replace those destroyed by flooding.

A large force of men have been engaged in cutting timber from the area to be flooded since April, 1920, and considerable work still remains to be done.

Loch Raven Tunnel

Water is conveyed from Loch Raven to Montebello filters thru about ½ mile of 10-foot cement-lined steel pipe, and six and one half miles of 12-foot tunnel cut thru solid rock. Some portions of the tunnel are unlined, some are lined with brick, and others, the weaker portions, were relined with reinforced concrete in 1914. Tests made last December revealed the fact that the tunnel leaked badly at two points, under pressures far below that which would be put upon it by the water impounded back of the new dam.

The weakness of the existing tunnel makes it very desirable to do one of two things; either to reline it with reinforced concrete, or to build a new one. On account of the large volume of water consumed, it is impracticable to shut down the tunnel long enough at one time to do the relining.

A new tunnel is eminently desirable, and could probably be built for about $4,000,000.00. Such a tunnel would insure the safety of the city's water supply, would permit the relining of the old tunnel, would permit the filters to be supplied directly by gravity, would effect a saving at the present time of over $100,000.00 a year for power, and would provide a greater impounding reservoir without resorting to pumping, as the friction losses between Loch Raven and Montebello would be reduced four fold.

The cost of a new tunnel at the present time however, is prohibitive, and in order to use the tunnel as it exists to-day and to insure it against pressure of water back of the dam, and to permit adequate control of the water being withdrawn by the pumps, some means had to be provided for its proper regulation.

Balancing Reservoir

A knowledge of operating conditions is essential to an understanding of the new balancing reservoir now under construction. The pumps at Montebello are set in a pit 24 feet below the ground, and have their center line about five feet above the normal water surface at Loch Raven. Friction losses between Loch Raven and Montebello lower the water level in the suction well, a further distance of from 3 to 9 feet. The present method of operation is to open wide all Loch Raven gate valves, and to control the flow of water by means of the pumps at Montebello.

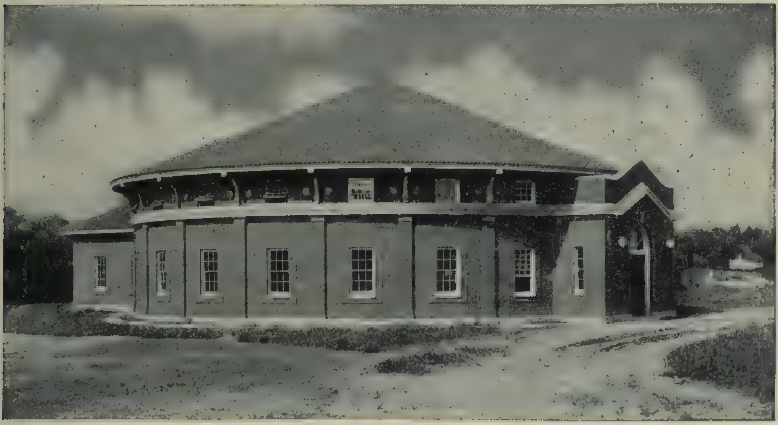


Fig. 1. Pumping Station at Montebello Filters

If, however, the water level at Loch Raven should be raised 52 feet, as it will be on completion of the new improvements, it would be impossible to open the gates at the dam without subjecting the tunnel to the full hydrostatic pressure of the water back of the dam, and it would be impossible to control, with sufficient accuracy, the flow of water by means of the gates at Loch Raven, as too wide an opening would subject the tunnel to pressure, or too small an opening would cause the pumps to lose suction. It was, therefore, determined to obviate this difficulty by converting an old quarry pond located over the tunnel near Loch Raven, at a point where leakage occurred during the test made last December, into a small balancing reservoir whose water surface will be maintained at elevation 200.

A shaft sunk to an intersection with the tunnel thru this reservoir, will thus permit water to flow freely in and out, and it is obvious that if it is admitted from Loch Raven, whose surface is 30 feet above that of the balancing reservoir, at a rate greater than that required by the pumps, the excess will pass over a spillway into a nearby stream, and the tunnel will be relieved of pressure.

If the reverse condition holds, and the pumps should require more water than was being supplied, the deficiency will be taken from the balancing reservoir, and there will be no danger of the pumps losing suction.

While the primary purpose of building the balancing reservoir was to obtain a means of controlling the flow of water, that would permit the use of the old tunnel without subjecting it to pressure, and to utilize the present pumping station, it further serves the purpose of reducing the suction lift of the pumps 8 feet, thereby effecting a saving of about 20% of the total cost for power.

The balancing reservoir, now under construction, will have a capacity of about 10,000,000 gallons in the upper five feet, and will be formed by building an earth dam across a ravine. It will have a crest 15 feet wide and a 3 to 1 slope on the upstream face, and 2 to 1 on the downstream face. It will be built without core wall, but will have a toe wall extending to rock and will be faced with concrete.

Surge Tank

Power for operating the pumps is transmitted thru underground cables—from the Monument Street power house, where connection can be made either with the transmission lines from McCall's Ferry hydro-electric plant, or from any of the large generating stations owned by the Consolidated Gas & Electric Co. One of the difficulties of operating the pumping station with power received over long distance lines is that there are occasional interruptions in the service. If power goes off the line for a single instant, all the pumps are automatically thrown out of service, and the sudden stopping of pumps causes water hammer due to the sudden checking of a column of water 7 miles long, and 12 feet in diameter.

Fortunately, the enclosed shaft forming the suction well is amply strong and has a great air cushion to help withstand the water hammer. It is believed, however, that it would be much safer if the shock could be avoided, and in order to overcome this, a shaft is to be sunk intersecting the tunnel line just before the pumping station is reached. The top of this shaft will be left open at elevation 200.5 or just ½ foot above the level of the spillway of the dam at the balancing reservoir. In case of a surging of water in the tunnel, it will simply overflow this shaft and discharge into the washwater reservoir at Montebello filters.

Low Lift Pumping Station

The low lift pumping station is located at Montebello, is circular in form and 86 feet in diameter. The pumps are arranged radially around a closed suction well 16 feet in diameter, which forms the terminus of the Loch Raven Tunnel. They discharge into a 6½-foot concrete conduit formed in the foundation wall of the building.

There are five different pumping units which operate against a total head of about 40 feet. The combined capacity of the pumps is about 240 million gallons per day, but the different units vary in capacity, and advantage is taken of this fact to secure the most economical combination necessary for the required volume of water. The pumps are operated by three-phase, 25-cycle, 550-volt induction motors, ranging from 275 to 600 horse-power. The power supplied to each motor is registered by a graphic wattmeter.

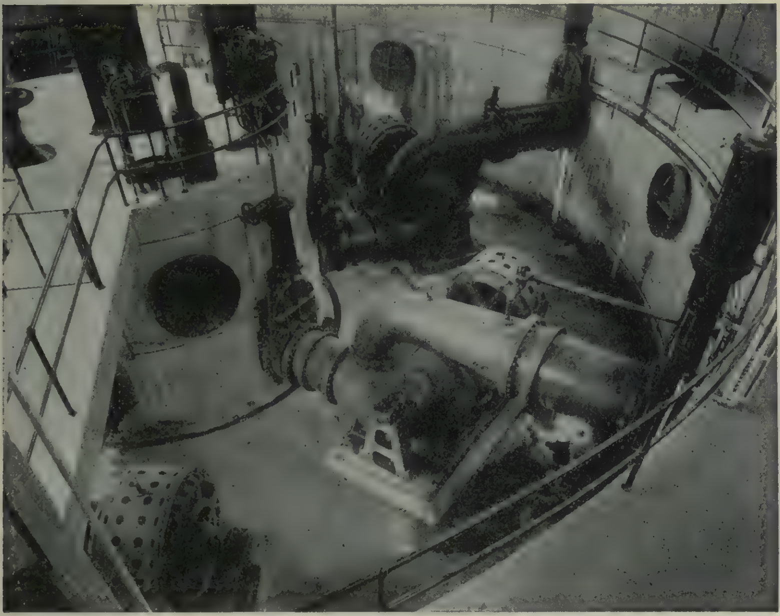


Fig. 2. Pump Pit in Pumping Station

An interesting feature of operating record is the low cost for labor as shown during the past six years. The station is operated by three shifts of 8 hours each, and never, since the plant was put in service, has more than one man been employed on a shift. The small number of attendants required to care for motor-driven centrifugal pumps is sometimes lost sight of in comparing the economy of different types of pumping machinery.

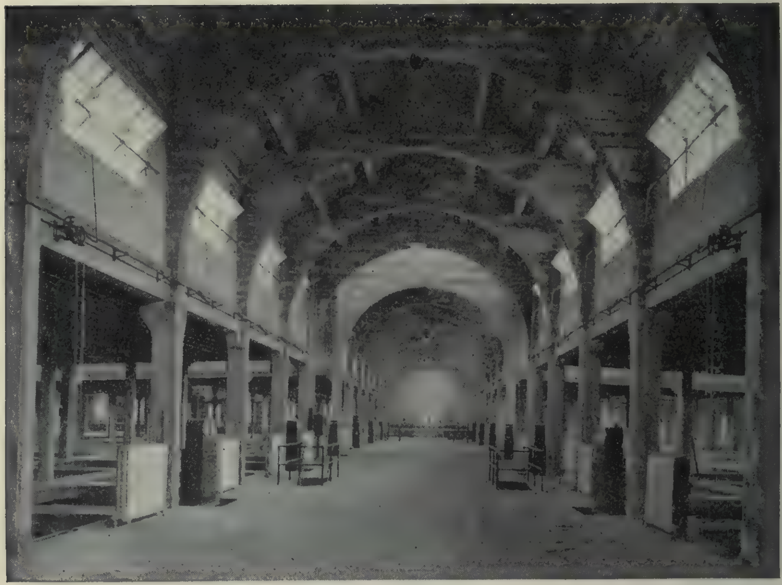


Fig. 3. South Filter Operating Gallery

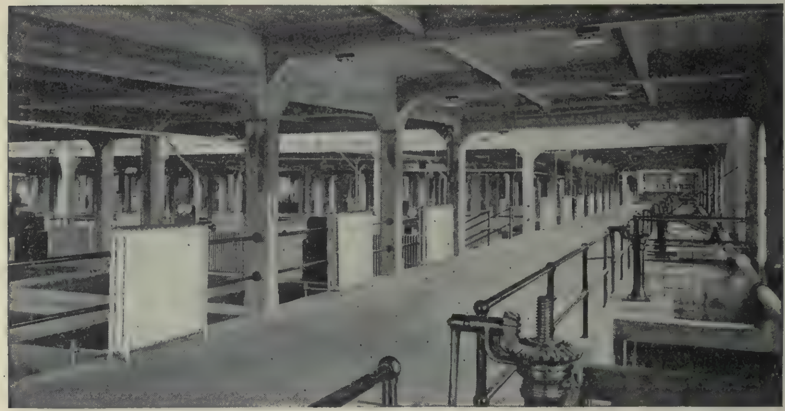


Fig. 4. Top View of Water Conduits in Rear of Filter Building

Chemical Treatment

As it is impossible to get a railway siding at the filter plant, all chemicals are transported by truck from the B. & O. siding, which is approximately two miles away. On reaching the plant both lime and alum are passed thru a small crusher and elevated by means of a bucket conveyor into overhead bins, which are capable of holding something over 1,500,000 pounds. From these bins the chemicals are drawn by gravity into buckets which are pushed along over-head trolley tracks, to the dissolving boxes, where they are put in solution and prepared for addition to the water.

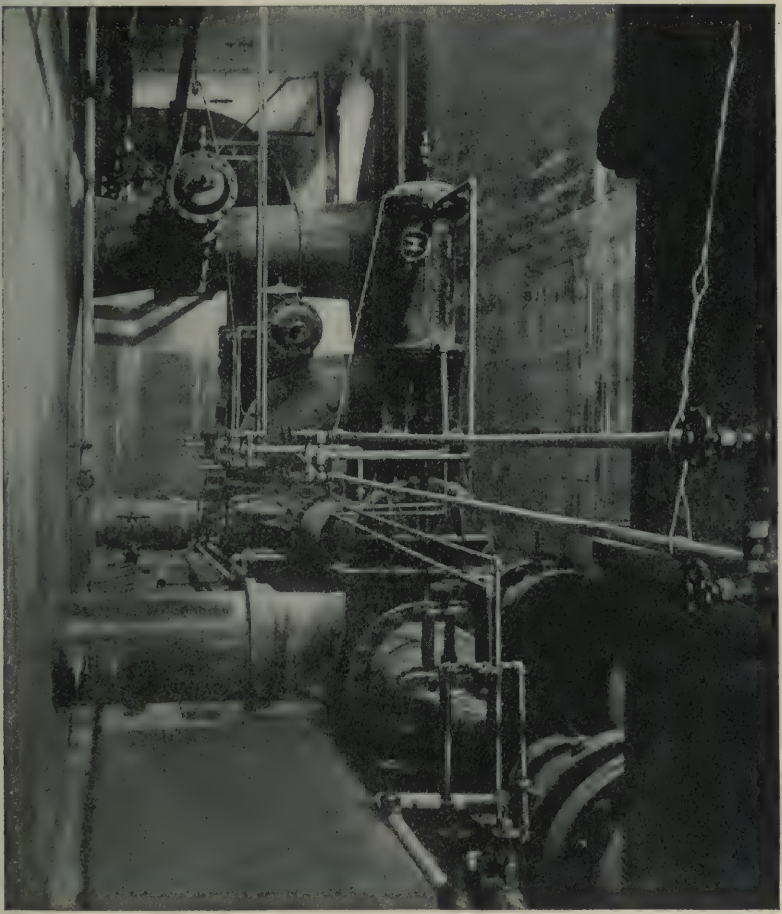


Fig. 5. View in Filter Pipe Gallery

A 96″x48″ Venturi meter placed between the pumping station and the filters is used as a means of determing the rate of applying chemicals. The chemicals were automatically controlled at first, but as the pumping rates vary by fixed amounts, it was found to be less trouble to operate the feed controllers manually, and the automatic features were abandoned.

Mixing and Coagulating Basins

After the application of the alum to the water, it is passed backward and forward thru the mixing basin where it is thoroly incorporated with the water. The basin is constructed with baffles of the around-the-end type, which are instrumental in securing a large, well-formed floc which settles out readily in the coagulating basins. There are two of these basins, each of which has a capacity of about 8,000,000 gallons, and, figured on displacement, they have a normal capacity of about 3 hours. From 90 to 95 percent of the sediment is removed from the water and settled out in these basins.

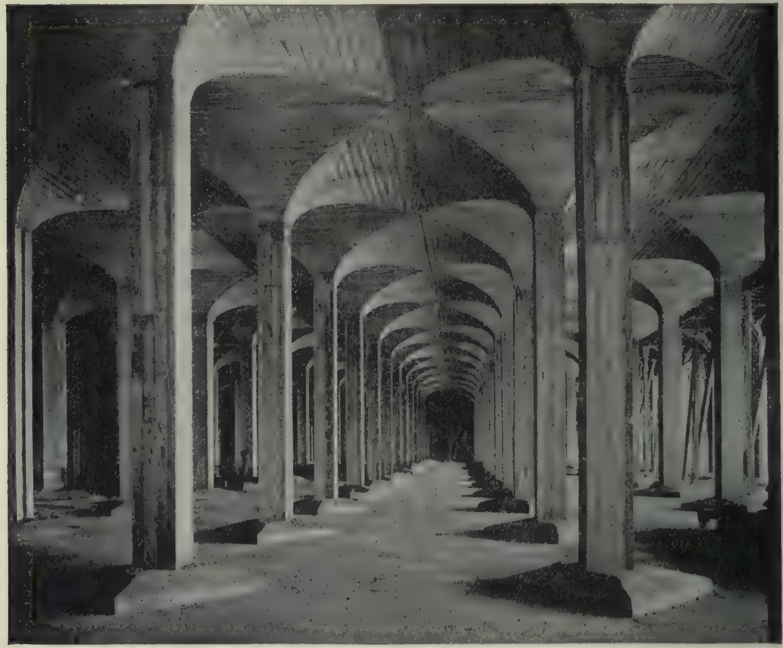


Fig. 6. Groined Arches in Filtered Water Reservoir

Filters

Montebello filters are of the mechanical or rapid sand type, and consist of 32 separate units, each having a daily capacity of 4,000,000 gallons or a total capacity of 128,000,000 gallons.

They are situated in surroundings of more than ordinary beauty, and the plant is housed in red brick buildings, covered with green tile roof.

The filters are located above basins which are directly connected with the filtered-water reservoirs, all of which have a combined capacity of a little over 17,000,000 gallons. While the capacity of these basins is relatively small, their value has been demonstrated many times, as we have been able to shut down the plant for short intervals without interrupting the supply. The application of liquid chlorine to the water as it enters the filtered-water reservoir is the last step in the process of purification.

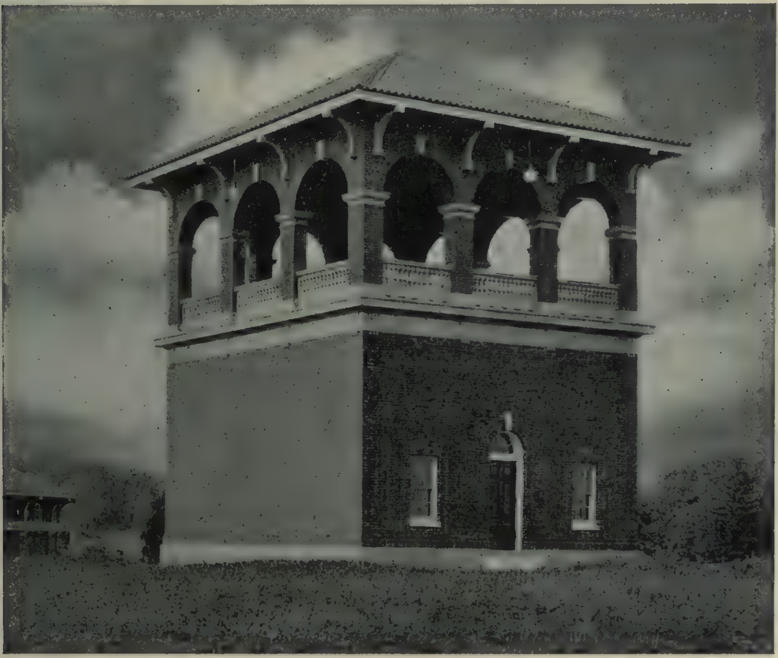


Fig. 7. Aerator Gate House

New Filters

During the summer of 1919, the filters were taxed to the utmost, and if money had been available at that time, a new plant in all probability would be a reality to-day. But, due to a careful and systematic conservation plan, and to decreased use for manufacturing purposes, the water consumption has been reduced to such a point that the design of a filter plant can be postponed until the more urgent need of a greater supply can be met.

Tentative plans for the new filters, involving a completely equipped plant, have been made. They contemplate a number of new features, among them a plant for the manufacture of alum. The new structures will be built on ground acquired for the purpose, adjacent to the present plant on the opposite side of Hillen Road. It is expected that before long, the new plans will be worked out in brick and concrete.

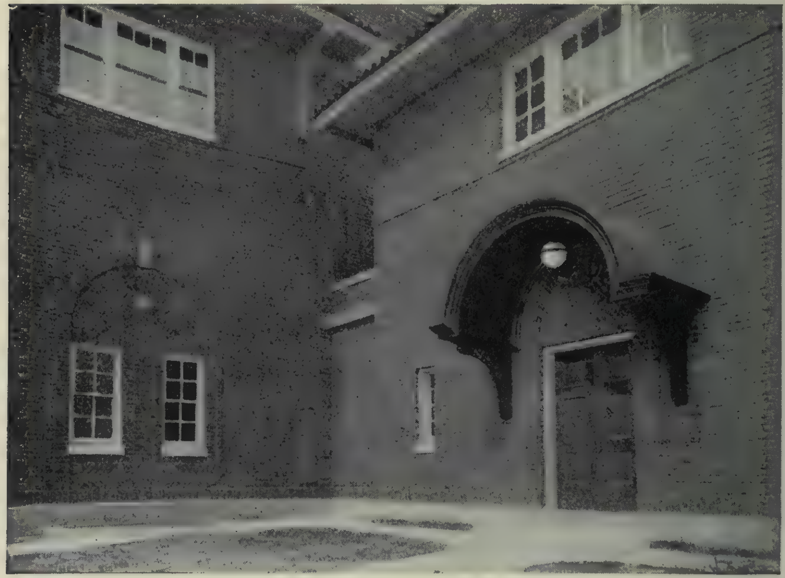


Fig. 8. South Entrance to Filter Building

REPORT OF GENERAL COMMITTEE ON SEWERAGE AND SANITATION

T. Chalkley Hatton, Chairman, Milwaukee, Wis.

The chairman of your Committee on Sewerage and Sanitation begs to submit the following described papers, which embrace his report.

Sub-committee A on Sewerage, submits a paper prepared by its Chairman, Mr. Langdon Pearse, entitled "Organization of Metropolitan Districts." This paper is of vital interest to the larger municipalities surrounded by the suburban towns or villages in which the same public service is necessary as in the larger city, and when it is found that this service, effectually carried out by each of the smaller units independently, becomes an ever increasing burden.

It has been found that the solution lies in either annexation or the combination of all the units into a Metropolitan District, and this has been successfully accomplished in many places.

Those members of this Society who have had to assist in preparing the laws governing the creation of a Metropolitan District have found the information needed for their guidance widely scattered, and, in some instances have no doubt missed much that is important. Mr. Pearse has, with great care and expense of time, collected the most important information and citations, which he ably presents in such forms as to be readily accessible. The paper will prove a valuable addition to the Society's literature.

Sub-committee B thru its chairman, Mr. E. A. Fisher, presents three papers—the first by Mr. N. Adelbert Brown, entitled "Sludge Handling at Rochester Sewage Disposal Plant." Mr. Brown, as engineer in charge of the largest installation of the Imhoff tank process in the United States, is well qualified to present to you a very valuable lesson as to how to handle sludges from Imhoff tanks successfully.

The Rochester plant has now been in operation long enough to afford us information which will prove useful in designing and operating sewage disposal plants, and particularly the volume, quality and disposal of sludges produced from such plants.

To your chairman there is one point in Mr. Brown's paper, which is of especial significance, and that is the conservation of the sludge for useful purposes.

The design of the Rochester plant embraced the depositing of the sludge in perpetuity in a deep valley adjacent to the plant, and also adjacent to what is bound to become one of Rochester's most beautiful parks. Even tho such disposition of the sewage might not create bad odors, its very existence in the vicinity of such a beauty spot would have become in time, a nuisance objectionable to all the people. By a little educational propaganda in the vicinity of the plant, Mr. Brown has found a market for a part of this sludge at a price almost equal to the cost of handling it. If this propaganda is properly carried on there is no doubt that his market will be so extended as to absorb all the sludge produced.

Mr. Brown's experience is only one of many which has come to your chairman's notice, that sewage sludges as produced in America, can and will be properly and profitably utilized when the agricultural community is taught its value, and when engineers devise economic means to reduce it to a condition which can be easily handled by such a community.

The second paper presented by Sub-committee B is entitled "Sewage Disposal for Small Municipalities" by Mr. John F. Skinner. This paper contains in a brief, excellent form, all the information which the engineer needs to obtain when called upon to design a sewage disposal plant for a small municipality. It is so well gotten up that, if properly followed, the young engineer need leave nothing undone before finishing his design; this is no doubt the purpose of its author.

The third paper presented by Sub-committee B is entitled "Sanitary Condition of New York Harbor and the Use of Fine Screens in New York City," by Mr. Kenneth Allen. This paper is particularly interesting to this Society, for three specific reasons: it presents the sanitary condition of the largest harbor in America and brings to us in a forceful manner how the protection of this harbor has been neglected, altho the attention of the public has been called to its rapidly growing pollution; it outlines some of the prospective works already designed to protect this harbor against sewage pollution; and it gives the results obtained from a fine screening plant equipped with one of the most widely advertised sewage screens, when handling a representative city sewage.

Sub-committee C presents a paper by its chairman, Mr. H. F. Bascom, entitled "Public Comfort Stations." This paper is of special value, first because it presents a very modern up-to-date public comfort station designed and built by Mr. Bascom for the city of Allentown, and second, because it gives us in one paper the information we are seeking as to what many other municipalities in the United States are doing towards the solution of this very important problem, and it is of more importance than ever before.

Since the corner saloon has almost disappeared, the necessity for public comfort stations has become more and more felt, not only in the business and congested districts, but also in the residential districts, and the time has come when American prudishness must be put aside and municipalities must solve this problem in a logical and sanitary manner, and we must not try to do it with a view of getting a monetary return therefrom.

Your general chairman presents a paper entitled "Dewatering of Sewage Sludge," which is in no way technical, his purpose being primarily to impress the Society with the necessity for better handling the sewage sludges produced in America and to have the Society use its influence in getting the proper department of the Federal Government to cooperate with it in investigating the economic possibilities of conserving sewage sludges for fertilizing purposes.

In closing this report your chairman wishes to extend his grateful appreciation to the hearty and prompt cooperation of the chairmen of your sub-committees in making his report a success, and he desires to take this opportunity of thanking Messrs. Brown, Skinner and Allen for preparing and presenting their several valuable papers.

DEWATERING OF SEWAGE SLUDGE

By T. Chalkley Hatton, M. Am. Soc. C. E.,
Chief Engineer, Milwaukee Sewerage Commission

A scientist connected with the U. S. Agricultural Department published the statement that the people of the United States were wasting $250,000,000 per year thru failure to utilize the fertilizing value present in the sewage produced by cities exceeding 10,000 population.

I remember being startled at the time by such a statement but this was before the war when we thought in millions rather than billions. However, I did make some extremely rough computations to check up his statement and am giving them to you just as they appear in my notes made in 1914 when I was just beginning to wonder what disposition the city of Milwaukee was going to make of the sludge to be produced from its proposed sewage-disposal plant which I had been engaged to design.

Cities of over 10,000 population in U. S. 755
Total population in such cities 45,000,000
Gallons of domestic and industrial liquid wastes per year
    at 100 gallons per capita 4,500
Tons of suspended solids in wastes 3,150,000
Say, 75% can be removed by plain sedimentation
    or . . . . .2,362,500 tons,

that the sludge contains 2% nitrogen as ammonia and that its value as low grade fertilizer is $2.50 per unit or $5.00 per ton. Then the total value of the waste material would approximate twelve million dollars annually.

How the scientific chap got at his result, I cannot say but you can see how I got at mine, and can pick the method to pieces if you please, still you will reach the conclusion that there was something in the statement well worth our earnest thoughts.

I know the answer that many, in fact most of our leading sewage-disposal engineers will make, for I have heard them make it: Why conserve the fertilizing value in sewage when it costs more to do so than you can get for it?

From an industrial engineer's viewpoint, such an inquiry would call for but one answer, as his client must be shown where and how he is going to get back in profits the dollar fifty when he spends the dollar, but to the municipal engineer, who is supposed to be advising a client composed of a great number of people whose profits are represented rather by its health and comfort than by dollars, it is more difficult to prove that it is not well worth to such a client the extra money the conservation of the fertilizing value in sewage would cost.

Adjacent to every city of 10,000 inhabitants, there is a community of agriculturists which carries on intensified farming and small fruit and berry growing and which needs for the purpose a fertilizer; the cheaper the fertilizer the richer the community becomes. What may enrich the outer community affects the inner community correspondingly. Thus a cheap fertilizer supplied in usable form to the small farmer and trucker adjacent to a city will swell the bank deposits and reduce the cost of produce even tho its production may increase the tax rate of those assuming it.

It may be that I am dreaming and my dreams magnify the value to the agriculturist of the average sludge produced from sewage. If I am, it is because I am not too young to recall how poudrette companies of years ago flourished in those cities where cess-pools were in common use and how anxious the little farmer was to stand in well with such companies even tho the product furnished was most disgusting to handle; my dreams may be the result of what I have seen accomplished by the small farmer by using tankage from garbage reduction plants; or from those farmers in Germany who buy and use the partially dewatered sludges from the nearby sewage-disposal plants.

During a recent trip thru Germany, I visited several sewage-disposal plants where plain sedimentation was the sole process used for sewage purification and where all the sludge was sold to the small farmer in the neighborhood for a sum much below what it cost to dewater it, and yet I didn't hear an engineer express the opinion to the effect that such a method of disposal didn't pay: on the contrary, everyone expressed the opinion that if the sludge could be dewatered just enough to make it easily handled, it was the best and only way to get rid of a nuisance which he had found by experience would continue to grow until it became a nuisance to the whole community.

During a recent visit to some of the most important sewage-disposal plants in England, I found practically the same methods of sludge disposal being carried out as I witnessed in 1907. English engineers seem to have made little or no progress in eliminating the sludge nuisance which is apparent in all of their plants where the sludge is not dumped in the sea. Several of the leading engineers expressed to me that the time had come when this matter must be given far more study and that a better way of meeting the almost overwhelming nuisance must be found.

England has been building and operating sewage-disposal plants much longer than any other country. Its tendency is to follow along well-known lines and as one engineer expressed it to me "To get both feet firmly planted before taking one from the ground, but that the time had come when conditions demanded that the foot be lifted." Dr. Calvert, who is chief investigator of sewage-disposal plants for the National government, told me that as the municipalities got upon their feet financially, they would be required to carry out more sanitary methods of disposing of their sewage sludges. All of the foregoing is explanatory of the following statement: That the time has come when American engineers should give more consideration and study to the sanitary disposition of sewage sludges regardless of the cost, or the municipalities operating disposal plants will find, as their population and the population in their immediate neighborhood increases, their sewage-disposal plants will become as unpopular as they now are in England.

Assuming for the moment that it is desirable to conserve, so far as practicable, the fertilizing values in sewage sludges, there is one question which must be considered—What is the local market likely to be for the sludge or will it be necessary to secure a market where transportation becomes a serious item.

If the local market can take all the sludge produced, it can be easily transported in bulk in wagons or trucks, and the dewatering need not be carried below 75% moisture: if the sludge must be transported upon cars, then it must be dewatered to a much lower moisture—probably to 10%—when it can be more profitably used as a base for a high grade fertilizer, altho the city of Bradford, England, reduces the moisture in its sludge to 25% by pressing alone, ships it in bulk in cars and finds a ready market.

If it is to be dewatered to about 75% or a little less, it can be so done by either drying on sand or stone beds, pressing thru filter presses or centrifuging; if it is to be dewatered to 10% moisture, it is more economical to take out the larger volume of water by one of the three methods above mentioned and the balance by some type of heat dryer.

The most economical method of dewatering to 75% moisture largely depends upon the character of the sludge, the climatic conditions and the local nuisances likely to arise from outside drying. An illustration of the probable cost of dewatering by drying on sand or stone beds is given in Mr. N. Adelbert Brown's paper presented at this meeting of the Society, to-wit: From 33 to 36 cents per cubic yard, exclusive of overheads, the material being sold to the neighboring farmers for from 25 to 37½ cents per cubic yard.

The cost of dewatering by pressing has been determined after many years of operating the Worcester and Providence plants where the cost runs from 79 cents to $1.25 per cubic yard, exclusive of overhead.

The cost of centrifuging may be safely taken from the Herrenhausen disposal plant, which treats the sewage from Hanover-Linden, and where the centrifuge has been successfully used for several years for dewatering the sludge from plain sedimentation tanks without the use of lime or other precipitant.

Converting the cost of German labor to the cost of American labor, the cost of centrifuging such sludge is 12 cents per cubic yard and the moisture content in the resultant sludge is about 70%.

The cost of dewatering from 75% or 70% to 10% moisture can easily be estimated, as the process is not unlike the removal of moisture by heat dryers from many substances used in the industries, and manufacturers of the modern direct-indirect heat dryers will guarantee the removal of 10 pounds of water per pound of combustible consumed; or 6000 pounds of water per hour can be removed from sludge by such a dryer, say, 84 in. in diameter by 60 ft. long.

If the amount of nitrogen contained in the sludge warrants the cost of transporting it by rail or boat a considerable distance, cost of reducing it to 10% moisture is justified; otherwise a market not exceeding from five to ten miles haul should be found for it and the limit of moisture reduced should be from 65 to 75% in which condition it can be easily transported and handled by the farmer, trucker and fruit grower.

An illustration of what can be done towards marketing low grade sewage sludge may be given here in Baltimore where for years a contract was carried out by which the contractor took the partially dried sludge from the sewage plant, dried it to 10% moisture without cost to the city, and, when the nitrogen content of the sludge was 2% or more, he paid the city 80 cents a unit therefor, which not only brought the city a profit but helped materially to solve the sludge problem.

What Baltimore seems to be up against is to get some practicable method of reducing the moisture in its sludge to 70 or 75 per cent and centrifuging may be the solution of the problem.

Another illustration of what can be done towards conserving the value in sewage sludges is set forth in Mr. Brown's paper on sludge disposal at Rochester and previously alluded to in this paper. Mr. Brown found that by a little education promulgated around the neighboring agricultural communities, such a ready market was found that he was warranted in increasing the selling price 50% and I predict that in a short time he will be able to increase this price and dispose of all the sludge produced. This is just what happened in Germany and it will happen here if proper educational methods are pursued and the sludge is produced in usable form.

The sludge nuisance can and should be eliminated from all sewage-disposal plants and until this is done in a sanitary manner, sewage disposal will never be the success in the public eye which water purification has reached. Engineers should recognize that to dispose of this highly putrefactive substance by dumping it upon ground and there letting it rot is not the final solution of the question, even tho the cost may be small; such a disposition will sooner or later prove a nuisance to any community, which it will not stand, and the engineer will come in for his share of condemnation.

If there is a value in the sludge, and there is in all sludges, it should be conserved so far as local conditions warrant, even tho the cost is greater than the direct monetary returns. This value should be better known by those producing it as well as to those who might profitably use it. The best medium to determine this value and to transmit such determinations to the public is the Bureau of Soils of the United States Agricultural Department, which should, in my opinion, thoroly investigate the whole subject, making growing tests from all kinds of sewage sludges and publishing the records so broadly that those in need of a low grade fertilizer may know what value it may be to them.

The Agricultural Department of the Imperial German Government, prior to the war, made exhaustive studies of this subject, with the result that all sewage sludges from the principal sewage works of Germany are in such demand by the neighboring farmers that none is apparent about any of the works there which I recently visited. In fact, so far as I was able to observe, Germany had no sludge nuisance like England and America, and what the Germans have done, we can do equally as well.

I would therefore strongly urge this Society to appoint a special committee to interest and co-operate with the Bureau of Soils of the United States in bringing about an immediate investigation of the disposal of sludge as a fertilizer.

ORGANIZATION OF METROPOLITAN DISTRICTS

Report of Sub-Committee on Sewerage of the Committee on Sewerage, Sanitation and Public Comfort Stations

Langdon Pearse, Chairman, Chicago, Ill.

With the increased attention to sanitation and, in particular, the development of pure water supply and clean waterways, considerable activity has resulted in the formation of various commissions, boards or districts, looking toward the provision of facilities for two or more municipalities acting together. These efforts have come about thru the legal difficulty of co-operating without some method of joining responsibilities by organization, and with the knowledge that better development can be had thru utilities, such as a water system or sewers, planned to serve a drainage area or district rather than individual towns by political boundaries. This tendency was early recognized in England thru the formation of river boards, such as Birmingham, Tame and Rea Drainage Board, under whose control are the removal and disposal of sewage of Birmingham and surrounding territory. Such boards in England have been jointly organized under various parliamentary acts for the cleaning of streams to prevent nuisance. In the United States the tendency was originally toward the formation of commissions organized and empowered by the state to carry our specific work. Among the earlier commissions were the Metropolitan Sewerage Board in Massachusetts, serving Boston and the metropolitan area around, and the Metropolitan Water Board. These two were later consolidated into one board after the major portion of the work had been accomplished. The Water and Sewerage Board has developed largely into an operating organization. On the other hand, in the West, in Illinois, the formation of sanitary districts received an early start, with the enabling act in 1889 forming the sanitary district of Chicago, a separate municipal corporation with broader powers than those of the Massachusetts Commission, being a separate municipality overlying other municipalities, but with a particular purpose and indefinite life. Further, broader bonding and taxing powers were given than in the East. Other enabling acts have been passed in Illinois and in Indiana. In New Jersey, the formation of the Passaic Valley sewerage commission and such joint projects as the Plainfield, North Plainfield and Dunellen Sewerage District, have added to the list.

In the desire to obtain municipal ownership of waterworks in the State of Maine, the water district idea was developed largely thru the efforts of Mr. Harvey B. Eaton, an attorney, who has summarized the history and enabling acts very completely in a paper entitled "Maine Water Districts and Appraisals" published in the New England Works Association (XIX, 147, 1915).

The Maine water districts resembled the Sanitary District of Chicago, in that they had bonding and taxing powers and were overlying municipalities organized for a specific purpose, in the water districts, that of serving water. A number of districts have been organized in Maine. Elsewhere might be mentioned the Greater Winnipeg Water District and the Metropolitan Water Board of London (England). There are also a number of private water companies supplying groups of towns.

In a report upon the metropolitan water and sewerage systems made to the Essex Border Utilities Commission, Ontario, Canada (1917), Morris Knowles has covered very broadly the metropolitan-district idea, pointing out the need of community cooperation, the methods of securing unity action by (1) annexation, (2) extension of municipal jurisdiction, (3) contracts between municipalities, (4) county administration, (5) private enterprise, (6) metropolitan districts. Various examples are discussed, and the difficulties. The methods in vogue of payment of costs are also discussed, chronologically.

Our committee has tried to summarize in convenient form most of the existing organizations. It is hoped that discussion may be promoted and possibly further examples cited to make the report more complete.

No mention will be made in this report of the commissions organized to make engineering reports or metropolitan projects, such as the Metropolitan Sewerage Commission (N. Y. City), Commission on Additional Water Supply (N. Y., Hering-Burr-Freeman), Charles River Dam Commission (Boston) and others. Their field has been a useful one, in most cases paving the way for construction and leading to broader acts for the construction organization.

In general, it is the purpose of this report to cover largely the districts formed for sewerage or drainage of metropolitan areas, and not the drainage of farm areas. For the purposes of constructing the sewerage systems of large metropolitan areas, and the disposal of sewage therefrom, with the increase of population and the need of more complete methods, various schemes have been tried as outlined. These may be summarized according to the degree of authority given, and appear to fall under three general groups:

1. Commissions or boards formed by city councils for the specific purpose of building intercepting sewers largely and practically within the confines of one municipality. These hardly come within the definition of the metropolitan districts serving two or more municipalities, but should be mentioned because of the organization of such commissions as the Fitchburg Sewer Commission, and the Syracuse Intercepting Sewer Board, and others.

2. Boards or commissions appointed by elective officers of cities, county or state, given resources, either limited by specific act or by action of the municipal or Federal bodies governing the municipalities composing the district. Under this classification might be placed such boards as the Metropolitan Water and Sewerage Board, the Passaic Valley Sewerage Commission, the Commission of the District of Columbia and others.

3. The formation of sanitary districts which are complete municipalities in themselves, with powers of taxation, with bond issues dependent upon referendum, and with officials appointed by county or state officers. Under this classification come the smaller sanitary districts in Illinois, such as those organized at Decatur, Bloomington, the North Shore Sanitary District, and Downers Grove.

4. Sanitary districts organized as municipalities with complete taxing and bonding powers, without referendum on bonds, with governing officials elected by direct vote of the people residing within the limits of the district. Under this classification comes the sanitary district of Chicago.

Practically all the districts mentioned and discussed in this report are those lying within the boundaries of one state. The committee has thought it desirable to call to the attention of those interested the need of some form of organization which will insure co-operation between districts lying in two or more states. With the growth of pollution in streams and the difficulties in obtaining suitable water supplies, such metropolitan difficulties may occur on stream watersheds, both from the water and sewerage standpoint, involving two or more states, as in the case of the Ohio River, for instance, involving Ohio, Kentucky, West Virginia, Pennsylvania, and in Missouri River territory in the vicinity of Kansas City where territory lying in Missouri and Kansas has to be considered. Such relations under the governmental organization of the United States would appear to require a Federal Act covering the creation of river or drainage boards, with powers extending over several states, to coordinate effort and use common policies in matters relating to use of streams for sewage disposal and the taking of water supply therefrom. This would appear to be the next development in a chain of acts which has been gradually formed thru the last forty years.

To finance the necessary works, money must be raised. This is usually done by issuing bonds, or by special assessment. Occasionally part of the general taxes is also designated. Operating and maintenance charges, as well as the payments of interest and sinking fund to retire bonds, when issued, are generally met by taxation, or by special assessments and also by rates based upon service.

Where the power to issue bonds is given the amount to be issued is usually fixed, sometimes by definite figures (Fitchburg, Syracuse) but generally in terms of percent of the valuation of assessed property. In many states this is 5 percent, an amount fixed by the state constitution. In the Indiana acts, the percent is fixed at 0.8 of 1 percent for Indianapolis, and 2 percent in the general act (1913). In Illinois, the Sanitary District of Chicago has a 3-percent limit, whereas under the other Illinois acts, a 5-percent limit is set. The maximum rate of interest is also sometimes stated. The maximum rate of interest on bonds is often limited to 5 percent (Indiana), altho in the case of Indianapolis a 4½-percent limit was fixed. The retirement of bonds is also provided for, 20-year annual installments being common (Illinois, Indiana). In the Essex Border Utilities Act the limit was set at 30 years, whereas at Indianapolis 50 years was allowed.

In the older districts bonds may be issued without referendum for the corporate purposes. In the districts formed more recently, many acts require a referendum on the bonds, as a whole. Where the act specifically limits the amount in dollars, as a rule the act is the result of public agitation demanding particular relief.

In the case of the Illinois and Indiana districts special assessment has not been used to meet construction costs in Metropolitan organizations. In the Passaic Valley, however, the cost of construction was assessed or apportioned among the various constituent municipalities roughly in proportion to the service rendered. In the Vancouver sewerage act 30 per cent of the construction cost is to be assessed upon the municipalities in proportion to their land valuations, and the remaining 70 per cent in proportion to the valuation upon lands benefited. But in determining the division of operating costs, assessment is frequently made against the individual municipalities in the district, which in turn is distributed by taxes or service charges (Boston Metropolitan District, Passaic Valley, Miami Conservancy). In Illinois and Indiana, tax levies are made thru the usual machinery, to raise the money to pay interest, operating and maintenance expense, and provide a sinking fund to retire bonds.

The maximum rate of taxation is usually fixed. There would, however, seem to be a legitimate need for a minimum rate to provide necessary funds for running expenses.

In Indiana, for Indianapolis, a levy of two cents on the $100.00 was allowed, plus a levy for sinking fund and interest. The general Indiana Act provides for 0.25 of 1 percent.

In Illinois, the Sanitary District has a taxing power of ⅔ of 1 percent of the assessed valuation. Owing to the scaling of the amount by the County Clerk, a recent amendment has placed a minimum rate of 1.2 mills on the dollar. The general Illinois acts provide in one case for a rate not to exceed ⅓ of 1 per cent, and in the other for ½ of 1 percent, altho this latter may be doubled by a referendum rate.

In the Miami Conservancy District a levy of 0.3 mill the on dollar is provided for preliminary expenses.

The size of the governing board varies widely, from a minimum of three (Illinois general, 1917) to a maximum of 13 (New Orleans) in the U. S. and 17 (Essex Border) in Canada. Some acts provide for service without pay, others provide pay as high as $7,500 per year.

The limits set on the powers of the board vary. Some acts are very explicit on the terms of advertising contracts, etc., others are not. Ten (10) days is a common limit. Some prescribe thirty-one (31) days. The limit of expenditure without advertising is occasionally fixed, $500 being a common figure.

In general, the acts appear to have been effective in providing machinery for necessary work. Occasionally, where a referendum is required, the project has failed by lack of votes to authorize bonds (Bloomington and Normal) or has been delayed by failure to seek authorization of bonds. The limits set by percents of valuation in some cases have proved inadequate, and in future acts should be chosen with greater care, to provide necessary funds, both by taxation and by bond issue.

Greater Vancouver Sewerage District

The Greater Vancouver Sewerage District was organized in 1913 for the construction and maintenance of the necessary intercepting sewer and sewage disposal plants for taking care of the urban district around the city of Vancouver.

New Orleans Water and Sewerage Board

The New Orleans Water and Sewerage Board was organized under an Act of the Legislature in 1889. The Act was made operative by vote of the registered tax payers of the city of New Orleans. The board is composed of 13 members, including ex officio the Mayor, Commissioners of Public Finance, Public Utilities, Public Property, President of the Board of Liquidation, Members of the Board of Liquidation and 7 members representing the 7 municipal districts, the latter appointed by the Mayor. These 7 members hold office 12 years each without pay. There are standing committees known as the executive, finance, sewerage and water, and drainage. The organization is operated under a general superintendent, who is also chief eingineer, with six departments. The clerical work and accounting is under the Secretary of the Board. Up to 1919 $32,000,000 had been expended.

The Sewerage and Water Board is, at present, limited to its outstanding bond issue of $20,000,000 4% bonds, and has a fund arising from a two-mill tax and the one-half surplus of a 1% debt tax, which, at present, aggregates about $2,500,000 per annum, from which it must pay interest on outstanding bonds, create a designated sinking fund for their retirement, and any balance is available for the extension and improvement of the sewerage, water and drainage systems, the city being obligated to budget enough for drainage maintenance and operation to have a reasonable surplus in the maintenance and operation fund to create a reserve fund for the renewal of portions of the drainage system. Water rates go to the maintenance and operation of the Water and Sewerage System and to the creation of a reserve fund for renewals and replacements in said systems.

Syracuse Intercepting Sewer Board

The Syracuse Intercepting Sewer Board is organized under an act providing for the appointment of three intercepting-sewer commissioners by the mayor who hold office for five years. The enabling act authorizes and empowers the board to construct certain intercepting and storm water sewers, and also regulate and improve particular water courses thruout the city. From time to time the act has been amended to provide for sewage disposal works, additional storm-water sewers and flood prevention. As amended, the act provides that bonds may be issued up to the amount of $3,200,000 to be sold by the city upon resolution passed by the board requesting funds in definite amount.

Fitchburg Sewage Disposal Commission

Under Chapter 461 of the Acts of 1910, State of Massachusetts, the Fitchburg Sewage Disposal Commission was organized by the appointment of three commissioners by the mayor with power to construct a system of sewage disposal. Under Chapter 354 of the Acts of 1901 the amount of bonds issuable was limited to $500,000, but this limit was extended by a subsequent Act providing for an additional $500,000. Under this commission the chief engineer was also the city engineer.

Metropolitan District Commission

Under Chapter 350 of the General Acts of 1919, Massachusetts, provision was made for the formation of the Metropolitan District Commission, whereby the Metropolitan Park Commission, existing under Chap. 407 of the Acts of 1893, and the Metropolitan Water and Sewerage Board acting under Chap. 168 of the Acts of 1901, were consolidated. The Metropolitan District Commission is to consist of one commissioner and four associate commissioners appointed by the governor with the advice and consent of the state council. The commissioner is to be appointed for a term of five years, and the associate commissioners will eventually be appointed for the term of five years, altho at first for one each for 1, 2 and 4 years. The commissioner is made the executive and administrative head, and receives an annual salary of not to exceed $6,000. The associate commissioners are to receive not to exceed $1,000. The commission may be organized into divisions as heretofore, with the usual clerical, police and engineering force. The expense of maintenance of the metropolitan parks, boulevard, water and sewerage systems are to be paid for as heretofore, provided, however, that the salaries of the commissioners and general office expense not clearly chargeable to maintenance work in any one of the districts shall be divided equally among the four.

The original metropolitan sewerage commission was formed in 1889 and the Metropolitan Water Board in 1895.

Washington Suburban District

Provision was made by Chapter 122, Acts of 1918, Maryland, for the organization of a sanitary commission in the counties of Montgomery and Prince George for the construction of sewerage works. The administration provides for three members, one to be appointed by the governor, and one by each board of county commissioners. Funds are to be derived by joint taxes for trunk lines and by special assessment for laterals. Service rates are to be charged.

Indianapolis Sewerage District

The act under which the Sanitary District of Indianapolis was organized is Chap. 157 of the Acts of 1917, of the State of Indiana. This Act is written for cities of the first class, and creates, in addition to existing executive departments, the Department of Public Sanitation, under the control of a board of three sanitary commissioners; two to be appointed by the mayor and the third to be the city engineer ex officio. One of the two appointees should be an engineer, nominated by the State Board of Health of Indiana. Said city engineer and the nominee of the State Board of Health nominate the third man for approval of the mayor. The commissioners serve for four years and are to be paid $3600 each during construction and $600 after construction. The funds are handled by the city comptroller and the city treasurer, and are to be raised by a special tax confirmed by a majority or all of the Superior Judges.

Bonds may be issued from two to fifty years in life, with an interest rate not over 4½%, in amount not to exceed 0.8 of 1% of valuation. The powers given to the commission are broad and cover and control the construction of sewage-disposal works, intercepting sewers, maintenance and operation, and also the handling of garbage, from the standpoint of disposal, but not collection. The board has the power of condemnation within five miles of the city and can enter for surveying. The act provides in detail for the legal machinery. The provisions as to the letting of contracts are unusually explicit, providing for the advertising once a week for three weeks, and then 10 days interval to date of receiving proposals, which are to be accompanied by a deposit of at least 2½% of the amount of the bid. Contracts may be let at less than the estimates of the Board. The validity of the letting can be questioned only within fifteen days of the execution of the contract. For general expenses taxes may be levied to the amount of two cents on each $100 valuation. In addition, a levy may be made to pay interest and principal on the bonds. Payments to the contractor on partial estimates are limited to 80%.

Sanitary Districts in Indiana

Chap. 307 of the General Laws of Indiana, 1913, is an act providing for the incorporation of sanitary districts. The original act provided that two or more incorporated municipalities in any one county might form a sanitary district, upon petition of 500 legal voters, and upon the majority vote passed by each municipality in an election held for the purpose. Five trustees are to be appointed by the governor of the state. The act provides for the construction of works, including sewers, sewage-treatment plants and pumping stations, and for the issuing of bonds in an amount not to exceed 2 per cent of the valuation, together with the levying of taxes to pay the interest and principal. The bonds shall not run more than 20 years. All contracts worth over $500 shall be advertised 15 days. Taxes may be levied in an amount not to exceed one-half of one per cent of the valuation of the taxable property. Biennial reports are to be made to the governor.

The original act was amended by Chap. 11 of the General Laws of 1919, providing for the appointment of the five trustees by the judge of the Circuit Court of the county in which the district may be located, and providing further for the salary of $500. The power of the board was further widened to provide, not only for handling sewage, but also for handling and the disposal of garbage and refuse. The issue of bonds was limited to two per cent of the valuation and the rate of interest was not to exceed five per cent. The tax levy was reduced to one-fourth of one per cent.

The District of Columbia

The District of Columbia, which is the seat of government of the United States, as defined by the Constitution comprises a territory of seventy square miles, ceded by the State of Maryland to the United States and located at the head of tide water on the Potomac river. The population, July 1, 1921, was 460,000.

Under powers conferred by the Constitution, the Federal Congress exercises exclusive and almost unlimited powers over the population within this territory. After a varied experiment for three quarters of a century with local self government, in 1878 Congress took away all such rights and placed the District under a commission form of government, with a board of three commissioners appointed by the President of the United States each for a term of three years with no limit as to reappointment. Two of these must have resided in the District for a period of three years preceding appointment, which is subject to rejection or confirmation by the U. S. Senate; the third must be an officer of the U. S. Army, of the Corps of Engineers not below the rank of Major, detailed by the Secretary of War. The salary is $6,000 per annum each, since this board was designated by Congress as a "Public Utility Commission" and granted the powers usual to such commissions in the various states; prior to that the salary was $5,000 per annum each.

The Commissioners of the District of Columbia constitute a governing board that is purely administrative. Exclusive of their function as a Public Utility Commission, they have no broad governing powers, and what may appear to have considerable scope, are in reality so restricted by the acts or the action of Congress as to possess only the barren powers of recommendation. In this connection it is to be noted that both the Senate and the House of Representatives maintain a standing "Committee on the District of Columbia," and in addition the Appropriations Committee of the House has a permanent sub-committee which in effect is authoritative in all fiscal matters.

The commissions submit the annual estimates for the District of Columbia to the Secretary of the Treasury, who transmits them to Congress. The committees of both houses consider in turn these estimates and report the amount of each item that in their judgment should be allowed. This report constitutes the District of Columbia appropriation bill which goes first to the House of Representatives out of the House committee, and when passed by that body with such amendments as may be made on the floor, then to the Senate for committee report and consideration by Senate, thence to joint conference committee of the two houses for adjustment of differences, thence back to each house for final passage, thence to the President of the United States for approval of this annual appropriation bill.

Not all the amounts thus appropriated in great detail as to items are expended under the direction of the Commissioners of the District of Columbia, but come under the exclusive control of the Departments of the Federal Government, such as War, Justice, etc. Sixty per cent of all amounts appropriated must be paid by direct local taxes, which as collected go directly into the Treasury of the United States. In this aspect of fiscal matters the sole duty by law of the Commissioners of the District of Columbia is to fix the local tax rate such as to insure payment into the Treasury of sixty per cent of the amount decreed for expenditure by Congress.

As Congress fixes just what streets are to be paved and what school houses built and the amount allowed for each individual item, the expenditure of the appropriations may be considered purely administrative. The Commissioners have no bonding powers, and no taxing powers except as noted, and no referendum is permitted the population on any subject.

The authority and activities of the Commissioners of the District of Columbia, are limited entirely to the District of Columbia and to such parts only as are not assigned by Congress to Departments or Bureaus of the Federal Government. For example, all the parks, large and small, but one comes under the War Department, including the Police force for parks; the one exception is the Zoological Park which comes under the Smithsonian Institution. The water supply is under the War Department except only the municipal distribution mains and house meters. Charities and correctional institutions come under the Department of Justice or a special board designated by the President, and for another example, the care of the insane comes under the Federal Department of the Interior which controls the local asylum of St. Elizabeth's, to which nearly a million dollars a year of local taxes are devoted.

New Jersey

"The Joint Meeting of the Inhabitants of the City of Plainfield, the Boro of North Plainfield and the Boro of Plainfield" is the corporate title of the joint municipality which handles the sewage and treats it at Green Brook Park.

The first step was the passage of a law by the state legislature in 1910 permitting two or more municipalities to join in a contract for the collection and disposal of sewage and authorizing such joint municipalities to acquire land outside of their own boundaries for sewage-disposal sites and defining procedure in claims for damages. The second step was the execution of a contract among the three municipalities providing for proportioning costs of construction and operation. The division of the cost of construction was somewhat arbitrarily determined for the reason that the above mentioned law states that any municipality having paid not less than 25 per cent of the initial cost shall have a veto power on all matters of expenditure. North Plainfield chose to pay this proportion in order to secure such veto power. The division of costs agreed upon in percents was Plainfield 68, North Plainfield 25, Dunellen 7. All new construction work and enlargements are paid for in this proportion, but the provision is made that enlargements made necessary by the abnormal demands of any one municipality over its proportionate share shall be paid for accordingly by such municipality. Provision is made for arbitration of disputes by appointees from each party, these to select a third party and in case of failure to make such selection the courts make the appointment.

Money for construction costs was provided by bond issues of the individual municipalities, the money being provided from time to time in accordance with the engineers' progress estimates. Construction bills were approved by the engineer, passed upon by the "Joint Meeting" (the entire council of each municipality in joint session), then passed upon by each council independently, the money appropriated by each council separately and paid into the hands of the Treasurer, who then paid the bills by checks signed by himself, the president and the secretary of the Joint Meeting.

Money for operating expenses is also provided independently by each municipality, but thru taxation. The superintendent of the Joint Works provides an estimate of cost at the beginning of each year. Upon the basis of this estimate each municipality provides for its share in the annual tax budget. The proportion of operating cost borne by each municipality was to be determined, according to the contract, by the flow of sewage determined by Venturi meters, but has actually been divided in accordance with the number of house connections.

During construction the Treasurer never had any funds in hand. In order to expedite the payment of bills for operation the Treasurer, at the time of each quarterly meeting, requisitions each municipality for a sum sufficient to make up the balance in the treasury to $5,000.00. Bills are paid by the treasurer on vouchers signed by the operating committee. This committee consists of a representative of each municipality and meets twice each month. The members of this committee need not be councilmen. The contract calls for the appointment of the committee by the chairman of the Joint Meeting, but by mutual agreement, he is guided by the wishes of the various councils.

Operation is in the hands of the superintendents, who reports to the operating committee. All ordinary purchases are made on order signed by the superintendent. Larger items of operating expense are authorized by the committee, while enlargements, etc., involving several hundred dollars are referred to the Joint Meeting. After approval on roll call of the Joint Meeting the operating Committee assumes the payment of the bills in the usual way.

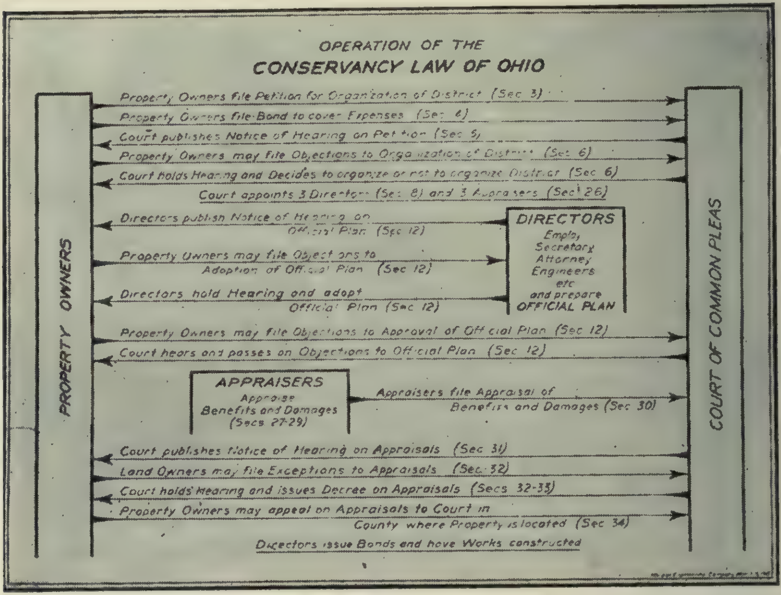
The paid officers are the secretary of Joint Meeting at $300 per year, treasurer at $300 per year, members of operating committee at $5.00 per meeting. (If councilmen they are prohibited by law from accepting this sum); and the superintendent of disposal works, who is engineer and chemist.

Passaic Valley Sewerage District

Passaic Valley Sewerage Commissioners is a corporate body existing under the laws of the State of New Jersey for dual purposes; first, to act as the agent of two or more municipalities, lying in whole or in part within the Passaic valley sewerage district, in the construction and operation of a system of metropolitan sewerage works for the relief of the polluted condition of the Passaic river; and second, to act, as an arm of the state, to prevent the pollution of the said river after a date fixed by the legislature.

There are five commissioners, one being appointed each year by the Governor to serve a term of five years. The salary of each commissioner as stipulated by law is two thousand five hundred dollars ($2500) per year. The Commissioners are organized with a chairman and a clerk.

The Passaic Valley Sewerage Commissioners have no taxing power. Money for the construction of sewerage works is made available thru definite appropriations authorized from time to time by the contracting municipalities, each municipality paying a proportionate share based on its net taxable valuations. The cost of operation and maintenance is to be apportioned annually among the contracting municipalities, in direct ratio with their respective sewage flows.


OPERATION OF THE
CONSERVANCY LAW OF OHIO
PROPERTY OWNERS
COURT OF COMMON PLEAS
Property Owners file Petition for Organization of District (Sec 3)
Property Owners file Bond to cover Expenses (Sec 4)
Court publishes Notice of Hearing on Petition (Sec 5)
Property Owners may file Objections to Organization of District (Sec 6)
Court holds Hearing and Decides to organize or not to organize District (Sec 6)
Court appoints 3 Directors (Sec 8) and 3 Appraisers (Sec 26)
Directors publish Notice of Hearing on Official Plan (Sec 12)
Property Owners may file Objections to Adoption of Official Plan (Sec 12)
Directors hold Hearing and adopt Official Plan (Sec 12)
DIRECTORS
Employ
Secretary
Attorney
Engineers
etc
and prepare
OFFICIAL PLAN
Property Owners may file Objections to Approval of Official Plan (Sec 12)
Court hears and passes on Objections to Official Plan (Sec 12)
APPRAISERS
Appraise
Benefits and Damages
(Secs 27-29)
Appraisers file Appraisal of Benefits and Damages (Sec 30)
Court publishes Notice of Hearing on Appraisals (Sec 31)
Land Owners may file Exceptions to Appraisals (Sec 32)
Court holds Hearing and issues Decree on Appraisals (Secs 32-33)
Property Owners may appeal on Appraisals to Court in County where Property is located (Sec 34)
Directors issue Bonds and have Works constructed

The commissioners act principally under the following laws as subsequently amended:

District Defined: Chapter 48, Laws 1902.

Enabling Act: Chapter 10, Laws 1907.

Each municipality provides money on its own initiative to pay instalments due under contracts with the Commissioners, and may, if it elects, incur indebtedness and issue bonds to an amount not exceeding five percentum of its net taxable valuation.

A total of twenty-two municipalities have to date sought participation in the Passaic Valley sewerage project.

Miami Conservancy District

The Miami Conservancy District is organized under the Conservancy Law of Ohio, the same being 104 Ohio Laws, pp. 13 to 64 inclusive, passed February 5, 1914. This law was prepared to provide the necessary machinery for works to prevent flood, to protect cities, villages, farms and highways from inundation and to authorize the organization of drainage and conservation districts. The machinery is very well illustrated by the diagram prepared of the Ohio Conservancy law by the Chief Engineer, Arthur E. Morgan. Briefly, a conservancy district is established by petition of the property owners to the Court of Common Pleas in any county. The court appoints a board of three directors and also three appraisers. The Miami district includes parts of ten counties. The appraisers appointed by the court have no executive functions. Their duty is to determine benefits and damages. The board of trustees is the governing body of the municipal corporation with discretion to organize the administrative offices as they deem best. The organization of the Miami district is as follows:

"The secretary of the district makes the immediate routine and administrative contact with the board of directors and has general supervision of the offices. Under the secretary are the three departments. The Department of Taxation is occupied with the clerical work of spreading the assessments on the tax books. The Farm Department is engaged in disposing of the surplus lands which were secured in right of way condemnations. Otherwise the entire work of the district is in the hands of the Department of Engineering and Construction.

The chief engineer is in direct charge of engineering and construction for the district. He employs men, makes contracts, which in important cases are presented to the board, and is in every respect responsible for engineering and construction.

All bills are finally paid by checks signed by the directors. This would not be necessary, but they chose to have that method of keeping in touch with the work. Frequently these vouchers covered large expense accounts, payrolls, etc., so that the number of vouchers signed is comparatively few.

The Department of Engineering and Construction is separated into two divisions. The Engineering Division exercises the usual functions of the engineer, while the Construction Division exercises the usual functions of the contractor. These divisions are manned as tho the job were let on contract and the responsibility is distributed on that basis. However, there is very close cooperation between the Engineering and Construction Departments since both are under the direction of the Chief Engineer.

The financing is provided thru three funds: (1) A preliminary fund consisting of a tax levy upon the property of the District not to exceed 0.3 of a mill on its assessed value, (2) A bond fund provided by the special assessments of benefits as approved by the Court. (3) a maintenance fund derived from special assessments levied annually.

Essex Border Utilities Commission

This act as amended is No. 15 of the year 1921, in the Province of Ontario. The Essex Border Utilities Commission is an interesting development, providing the necessary machinery for handling, not only the sewers and sewage treatment, but also water works, board of health, hospitals, hospital, park and town planning, for a number of communities. As at present constituted the commission consists of the mayors of five towns, two reeves and ten members elected every three years. Money is raised by special taxes and by the sale of debentures, the term of which shall not exceed 30 years. The cost of construction, maintenance and operation is divided in proportion to the benefit, as determined by the engineer. Questions are submitted to qualified voters for referendum and must be approved by at least three of the municipalities.

The Sanitary District of Chicago

Operative under the Act of May 29, 1889. The original act of May 29, 1889, has been amended in various years, both to extend the powers of the District and to cure various defects found, as well as to provide for annexation of additional areas. While originally drawn as a general act, it has been adopted alone by the Sanitary District of Chicago. Powers are granted by the charter to build channels, drains and docks, dispose of water power, and by the most recent amendment specific power to construct intercepting sewers, pumping stations and sewage treatment works. The district at present comprises some 45 municipalities, including the city of Chicago. For the purpose of administration, a board of nine members is provided, three of whom are elected every two years, and one of whom is chosen by the Board to act as presiding officer. The funds for the work are provided by the issuing of bonds, in amounts not to exceed 3% of the assessed valuation. For operating expenses, payment of interest and the like, provision is made for a taxing power not to exceed ⅔ of 1% of the assessed valuation. The most recent amendment provides for a minimum levy of 1.2 mills on the dollar. The area served at present is 395.51 square miles, and includes all of Chicago and 45 incorporated cities and villages.

Illinois Sanitary Districts

The difficulty of financing sewage disposal projects for the smaller cities of Illinois, ranging from 10,000 to 50,000 in population, led to a desire for a sanitary district act, which would suit their needs. The act creating the Sanitary District of Chicago did not prove applicable. Two acts are in existence in the laws of the State, one being printed in the Laws of Illinois, Fiftieth General Assembly, 1917, pp. 396 to 404, creating sanitary districts, and providing for sewage disposal; the other given in Hurd's Revised Statutes, 1919, Chap. 42, pp. 244 to 263, inclusive, being an act passed in 1911. The latter act is drawn largely with reference to villages taking water from Lake Michigan. Under this act, 300 voters may petition the County Judge of the county, thereby starting the machinery for an election for the formation of the proposed sanitary district. If formed, provision is made for a board of five trustees, who are appointed by the County Judge and two Circuit Judges. General powers are given to the sanitary district to construct works, and further levy an annual tax for corporate expenses not to exceed ⅓ of 1% of the valuation. Before any bonds can be issued, a referendum has to be held. The amount of bonds may not exceed 5% of the valuation. Under this Act, one Sanitary District has been incorporated, The North Shore Sanitary District.

Under the Act of 1917, several sanitary districts have been incorporated, including Decatur, Bloomington and Normal, and Downers Grove. The general provisions are somewhat similar to the Act of 1911, except that 100 voters may petition for an election for the formation of the district, and further that the board of trustees consists of three members appointed by the County Judge. Broad powers are given to the Board for the purposes of constructing sewerage works and sewage treatment. Money may be raised by bond issues to mature in not exceeding 20 annual installments; the amount of the bond issues not to exceed 5% of the valuation. Provision is made for levying of taxes to pay interest and annual installments, as well as for taxes for corporate purposes in amount not to exceed one-half of one per cent, providing, however, that an additional one-half of one per cent may be authorized by referendum.

Wisconsin

The Milwaukee Sewerage Commission operates under an Act entitled "An Act relating to the Sewage Disposal Works in Cities of the First Class" being the following chapters of the laws of Wisconsin,—608 of 1913, 328 of 1915, 607 of 1915, 304 of 1917, 657 of 1919. This act provides that the common council of any city of the first class may vote for the establishment of a sewerage commission, and if carried by a majority, the mayor appoints five members. These serve without pay. The commission covers construction of intercepting sewers and sewage treatment works. For financing a tax of one mill on the dollar may be raised. Bonds may be issued without referendum, unless petitioned by 15 per cent of the number of voters at the last preceding election. The bonds shall not exceed $10,000,000, or 5 per cent of the assessed valuation.

Provision was made in 1917 for approval of plans where other towns in the same county are doing similar work. This has been enlarged in 1921 to provide for a Metropolitan Sewerage Commission, consisting of 3 members appointed by the governor, one of whom is to be a member of the city sewerage commission. The work authorized will be financed by bonds running 20 years, and after the first 10 years to be redeemed in 10 annual instalments. Funds may also be raised for operation and maintenance by assessment on the cities and villages, to be raised by taxes.

Greater Winnipeg Water District

The Greater Winnipeg Water District was organized under Chapter 22 of the Acts of 1913, Province of Manitoba, and provides for the organization of a municipal corporation including at first four municipalities. The Board is made up of the mayor and board of control of the city of Winnipeg; the mayor and one member of the council of the city of St. Boniface, and the mayors or reeves, as the case may be, of the minor municipalities. The mayor of Winnipeg is chairman of the board. The purpose of this water district is to supply the inhabitants with pure water from a permanent source in bulk to each of the municipalities. The cost of service is to be arrived at on the basis of maintenance, operation, and management. One-half of the amount required annually to pay interest and sinking fund, maintenance and operation, is to be borne by the land as a tax. The corporation is authorized to borrow and issue bonds with interest not exceeding 5% per annum and a life not exceeding 50 years. The method of issuing bonds must be approved by a referendum vote of the city of Winnipeg. The corporation is authorized to levy taxes to pay interest and a sinking fund to retire the bonds. The act is very specific as to the financing, and, in particular, the taxation, both as to the spreading of taxes and the exemptions.

Board of Water Supply, New York City

This well-known board was authorized by Chapter 724 of the laws of 1905, New York State.

For many years it has been the custom of the city of New York when it had a large public improvement to carry out, to create a special commission for that purpose, having broader powers than possessed by any of the city departments. So the act was passed, with the object of securing administrative authority with broad powers and not subject to the many annoyances and delays to secure successive approval of the public bodies, as in the case of the regular city departments, and also to secure reasonable permanence in office. The act provides that a commission to be known as the Board of Water Supply, with three members, be appointed by the mayor, and further provided that "no member of said board shall be removed except for incompetency or misconduct shown after a hearing upon due notice, upon stated charges," this board to determine what sources were most available, desirable and best for an additional supply of pure and wholesome water for the city of New York, and report to the governing board of the city, the Board of Estimate and Apportionment. This board was to approve the outlined plan of the project for a new water supply, which could be submitted in parts or as a whole and be modified later, if desirable, with the approval of the same body. It was the duty of the Board of Water Supply to prepare contracts and carry out the work without any further approval of the governing board of the city.

The necessary funds were authorized from time to time by the governing board of the city, a strict accounting of which was kept by the auditing department and frequently reports were made to the comptroller and to the city authorities. The city of New York does not actually raise the funds and deposit them, as is the case in some cities, but it issues its corporate stock to take care of capital expenditures as needed from time to time.

The Board of Water Supply further has authority to appoint all necessary employees and to fix their compensation, observing, of course, civil service rules.

The contracts receive only the approval as to form of the corporation counsel, and the board has full authority to award contracts to other than the low bidder. With reference to this, the act provides that the board may select the bid or proposal which will, in their judgment, best secure the efficient performance of the work, and provides further that "no contract shall take effect until the Board of Water Supply or a majority thereof shall certify thereon in writing that its acceptance will, in their judgment, best secure the public interest and the efficient performance of the work therein mentioned." This is a privilege which has been very seldom exercised, but, nevertheless, has proved very valuable in some instances.

A great deal of the act is taken up with the procedure for the condemnation of real estate and trial of the cases, which is the same procedure that has been used by the city for a great many years; in fact, this whole Act is practically a repetition of the act under which the Aqueduct Commissioners operated between 1883 and the time of the abolition of that Commission in 1910.

In the preparation of this brief compilation the Committee desires to thank the following gentlemen for information kindly furnished, some of which has been used verbatim: J. R. Downey, Glenn D. Holmes, A. E. Morgan, R. B. Morse, Asa E. Phillips, J. Waldo Smith, Wm. Gavin Taylor.

THE SANITARY CONDITION OF NEW YORK HARBOR

By Kenneth Allen, Sanitary Engineer Board of Estimate and Apportionment, New York City

Many large cities have been forced to undertake works of main drainage and sewage disposal in order to protect their water supplies. This has been the case with Philadelphia and our larger lake cities, such as Chicago, Milwaukee, Detroit, Toronto and Cleveland. More cities have found such measures necessary in order to prevent the foul odors of decomposition. Of these Berlin, Amsterdam, London, Paris, Manchester, Leeds, Dublin, Marseilles, Glasgow, Havana, Boston, Worcester, Baltimore, and San Francisco are prominent examples. And sooner or later the City of New York will be forced to adopt some comprehensive plan in keeping with the magnitude and importance of this great metropolitan center.

At London the Thames was designated by Lord Bramwell as "a disgrace to the Metropolis and to civilization." It, and its tributaries were "turned into open septic tanks, and the broader reaches of the river as it then was, such as that between Westminster and Waterloo Bridges, had their banks covered with accumulations of offensive mud, which was exposed at low water, and in warm weather, under the influence of the sun, gave forth exhalations of almost objectionable character." (Dibdin.)

The result of this situation was the creation of a Metropolitan Board of Works, followed by the construction of the two great systems of intercepting sewers delivering their burdens at Barking and Crossness, below the city. Nevertheless, up to the introduction of chemical precipitation works at these two points in 1889 and 1891, respectively, the odor during warm weather was "most offensive and caused a serious nuisance.

The Seine below Clichy at Paris was described by Dunbar as formerly "a stream of black water, covered with grease, corks, hair, carcasses and mother filth," with a gray sludge on the right bank giving rise to "foul smelling islands." This resulted in the development of their celebrated sewage farms which, since 1894, have taken care of nearly all of the sewage of Paris.

Now while New York is much more favorably situated in this respect than most cities, the time is approaching when something on a larger scale than heretofore attempted must be done if certain areas of the city are not to pass thru a period of discomfort and with insanitary conditions such as many of the cities mentioned have experienced to their sorrow.

The unusually thoro and extensive series of investigations of the Bay Pollution and Metropolitan Commissions placed the situation squarely before the public, and with the opinions of the experts called in by the latter commission and in connection with the suit of the State of New York against the State of New Jersey and the Passaic Valley Sewer Commissioners, furnish ample grounds for apprehension.

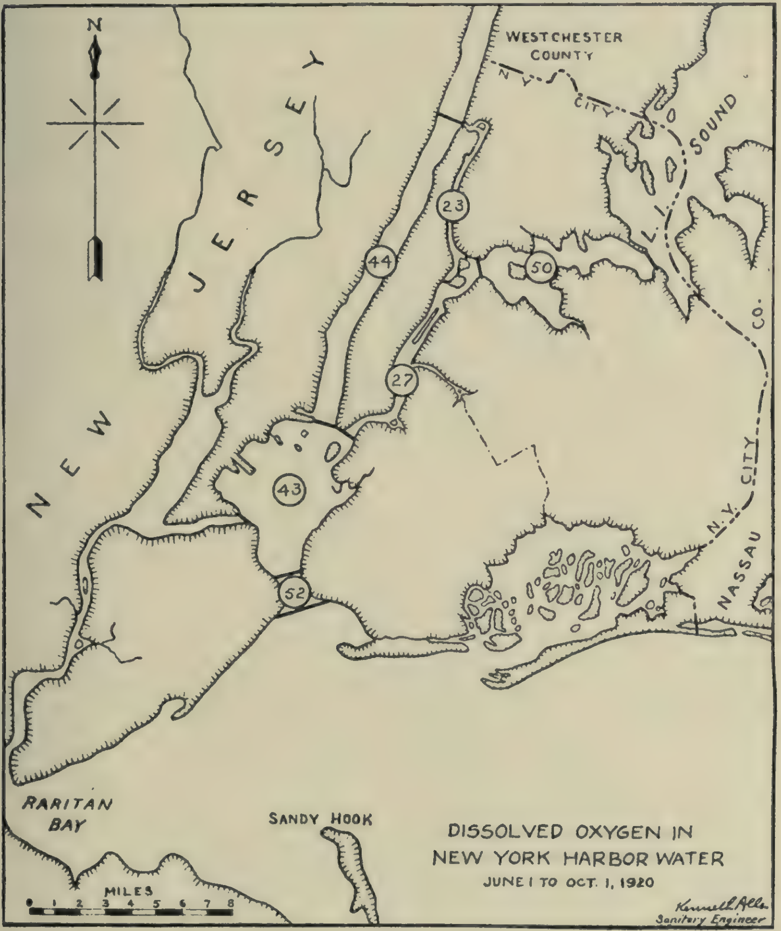


Fig. 1

Such high authorities as Dr. Gilbert J. Fowler of Manchester and John D. Watson of Birmingham, England, Professors Olin H. Landreth, C-E. A. Winslow, and W. P. Mason and Past

President Desmond FitzGerald were particularly emphatic in their statements. In the opinion of Professor W. T. Sedgwick, "There will surely come a time *** when the comparatively innocuous fermentation which now goes on in these bodies of water in the presence of dissolved oxygen will, by the absence of such oxygen, pass over into evil-smelling, unsightly, disgusting and dangerous putrefaction, with the result that what is now a comparatively decent and unobjectionable body of water will become a public nuisance and cry loudly for relief."

Now these opinions were expressed about eight or ten years ago, and it may be interesting to compare conditions as they are today with those that obtained then.

Superficially, as evidenced by sight and smell, the difference in the situation is not marked. Along the slips, and especially in the Harlem and Lower East Rivers, it is normally disgusting to those whose attention is directed to it, and at times, on warm, damp, summer evenings, a faint but characteristic sewage odor permeates the atmosphere along these streams. In cool weather, on the other hand, the only evidence of pollution is by vision, the water being cloudy at all times along the shores and carrying more or less scum with solids of sewage origin, both coarse and fine.

In the early investigations of the Metropolitan Sewerage Commission various tests of the harbor water were made, in which those for the ammonias, nitrates and nitrites as well as for bacteria were prominent, in accordance with current practise. But beginning in 1909 emphasis was laid on the test for dissolved oxygen, now generally recognized as the most illuminating of all tests of pollution of water. These determinations were kept up until the termination of the Commission's work in 1914 and have since then been continued by the Board of Estimate and Apportionment, under direction of the Chief Engineers Nelson P. Lewis and Arthur S. Tuttle.

As is well known, clean river or ocean water is usually nearly saturated with dissolved oxygen absorbed, for the most part, from the air. On mixture with polluting organic matter, such as sewage, the contained bacteria use up this oxygen in their life processes with an avidity dependent upon their concentration (degree of pollution) and the temperature. Owing to their dormant condition in winter there is little draft on the oxygen, which remains high in the main channels in spite of a relatively intense pollution; but in the summer their effect is readily recognized as a function of the pollution.

For this reason it has seemed undesirable to attach great importance to other than warm weather tests, and for practical reasons these have been limited in this discussion to the four months following the first of June. The averages for the several main branches of the harbor as determined up to 1921 are given in the following table.

Average Percent Saturation with Dissolved Oxygen of the Waters of the Main Branches of New York Harbor

Year	Samples No.	Hudson below Spuyt. D.	Harlem River	Upper East R.	Lower East R.	Upper Bay	Kill van Kull	Narrows
1909	404	72	55	86	65	67	79	83
1911	861	62	42	69	54	72	70	76
1912	150	58	—	—	49	64	65	71
1913	880	57	29	—	43	66	65	69
1914	477	50	30	50	40	71	—	68
1915	247	43	28	—	33	72	—	78
1916	176	46	24	—	26	64	—	63
1917	257	42	22	47	29	50	—	63
1918	60	54	23	50	21	56	—	61
1919	322	36	29	30	24	51	35	58
1920	294	44	23	50	27	43	42	52

Altho the depletion has not been uniform, the general impairment of the quality of the harbor water is quite apparent; and if it is recognized that when the degree of saturation remains less than 30% for several days in warm weather local nuisances are probable, and that with sustained total depletion an intolerable condition would result, the gravity of the situation is obvious. For it is to be remembered that the above figures are averages and that there are times nearly every summer when certain stretches of the Harlem River are entirely devoid of dissolved oxygen and when the saturation in parts of the Lower East River lies between 5 and 15%.

For several years prior to the dissolution of the Metropolitan Sewerage Commission in 1914 a nunber of influences served to focus attention on the matter of the relief of the pollution of the harbor. Aside from the voluminous publications comprising the findings of the Commission there were the hearings in the Passaic Valley Sewer Case, decision on which by the U. S. Supreme Court has recently been handed down and in which many of the most eminent American sanitarians testified. Then there was a study of the subject followed by a report to the Board of Estimate and Apportionment by Col. W. M. Black and Prof. Earle B. Phelps and, later, the establishment, under the Board, of the New York Sewer Plan Commission, followed by the Bureau of Sewer Plan. These were all instrumental in attracting attention to the subject.

For the past few years there has been little or no agitation in furtherance of improved sewerage, but the value of earlier investigations has been conserved and studies for the collection and treatment of sewage extended by the Board of Estimate and Apportionment in such a way as to conform to the development of the city and to improvements in the methods of sewage treatment.

In addition to this a number of projects for the interception or treatment of sewage have been officially adopted which, if not already constructed, will be put under contract at an early date. Among these are the fine-screening plant at Dyckman Street and the reconstruction of sewers in the Clarkson and Canal Street District with interception to a fine-screening plant at Canal Street, Manhattan; the construction of submerged outlets for the Truxton Street, Tiffany Street, Farragut Street and Old Ferry Point sewers in The Bronx; the interception of sewage from a large area in northern Queens to an outlet off Theodore Street; the sewerage of the Rockaways with an outlet off Beach 149th Street, Queens; the establishment of a fine screening plant at Paerdegat in Brooklyn, and the interception, with fine

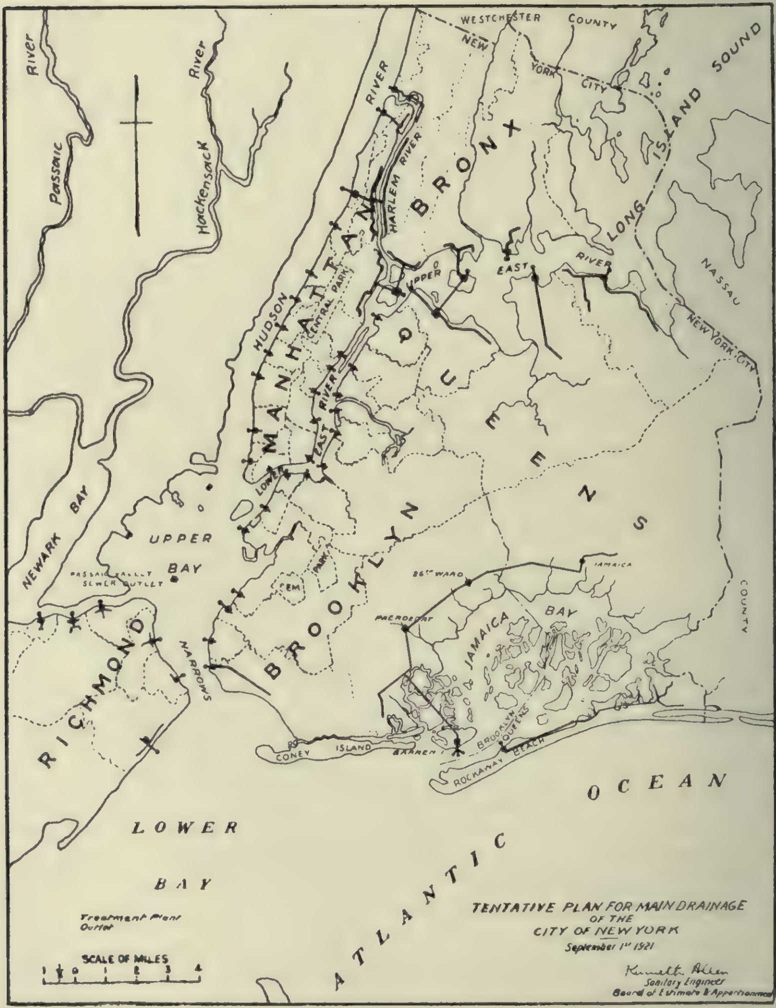


Fig. 2

screening and disinfection, of the sewage from a large area near Midland Beach and South Beach in the Boro of Richmond. All of these improvements have been in conformity with the general plan as developed in the office of the Chief Engineer of the Board of Estimate and Apportionment at the date of adoption.

The earlier studies of the Metropolitan Commission comprised the entire metropolitan area within 20 miles of the New York City Hall, covering 700 square miles, a perfectly justifiable proposition, since the pollution of the harbor is derived from the whole of this larger area. But failure to secure the co-operation of the New Jersey authorities led to the restriction of their plans to New York.

The outstanding features of these plans were as follows:

(1) The disposal of a large volume of sewage tributary to the Harlem River and from neighboring territory in Manhattan and The Bronx on Wards Island by sedimentation.

(2) The transfer of another large volume tributary to the Lower East River and the north shore of Jamaica Bay to an artificial island about 3 miles south of Coney Island where, after tank treatment, it would be discharged into the Lower Bay; and

(3) The collection of sewage from the remaining territory in all boros to selected points, where it would be treated, usually by fine screening or sedimentation.

Owing to a strong opposition to some of these features which developed at the time, the New York Sewer Plan Commission proposed as an alternative:

(1) The diversion by tunnel of the sewage tributary to the Harlem River to a point in the Hudson off West 155th Street;

(2) The substitution of an artificial island off Red Hook, just south of Governors Island, in the Upper Bay for the more remote outlet in the Lower Bay off Coney Island, except that the sewage would all be taken from the east side of the river.

(3) Local plants to provide for the balance of the city's sewage, as in the former plan.

These modifications were all feasible and that relating to the Harlem River was approved by the Bureau of Sewer Plan in 1915, with treatment by fine-screening and a submerged outlet in the Hudson nearly a half mile from shore. With a discharge forecast at over 100,000,000 gals. per day at this one point it is quite possible that some further treatment should be anticipated during periods of extreme drought.

Plans for the disposal of the sewage from that part of Brooklyn fronting on the East River have remained in abeyance altho this, to a considerable extent, controls the plan for the rest of the Lower East River and the Upper Bay.

The "Ocean Island" project of the Metropolitan Commission was objected to on account of the high first cost made necessary by the construction of a large tunnel, some 12 miles long, to the point of disposal before starting operation. On the other hand, a discharge to the Upper Bay, in order to produce an equivalent result, would involve a higher degree of purification for the sewage, would in any case increase the local pollution near the outlet close to the main ship channel, and, furthermore, it has been questioned whether the Federal authorities would consent to the construction of a new island on what is now an important anchorage ground. Nevertheless, such an island has been recently proposed in the interests of commerce.

It is suggested, however, that a way out of this dilemma may be found in the following plan:

There will be tributary to Wards Island from the three neighboring boros an estimated volume of 142,000,000 gallons per day by 1960. It has heretofore been the plan to treat this by plain sedimentation and to employ this method at the several local plants to be established along the shores of the Lower East River. By this means but about one-third of the putrescible matter would be removed, while it would be very difficult to find sufficient area for the local plants.

It is believed that experience with the activated sludge process has reached the stage when it may be said to be established as a standard method of treatment and one that produces a very superior quality of effluent. It is true that the question of dewatering the surplus sludge has not been fully solved and that the sludge from some sewages is much more amenable to treatment than that from others. Careful preliminary tests of activation and dewatering would therefore be necessary before any final commitment to this scheme, but it may be pointed out that the activated sludge process has already been or is about to be used at Worcester, Manchester and Reading in England and Milwaukee, Houston, and the Chicago Sanitary District in this country, besides a number of smaller towns.

Now if an activated sludge plant were substituted for plain sedimentation at Wards Island the well-oxygenated effluent would be such that in all probability:

a. Local treatment could be substituted for interception either to the Lower Bay or to an island in the Upper Bay.

b. Fine screening could be substituted for sedimentation at those local plants along the Lower East River where land for tanks would be difficult to secure.

The strategic advantages of Wards Island as a point for disposal are great. It lies close to three boros, two of which are densely populated in this vicinity, while the deep turbulent waters of Hell Gate offer ideal conditions for rapid diffusion and dilution of the effluent.

The dried sludge, rich in nitrogen, would appear to command a market as fertilizer which would go far toward offsetting the costs of operation. Unfortunately charges for power in New York are high, so that the whole subject would require careful analysis from the financial standpoint. But the prospect of reaching a satisfactory solution for this very vexed problem would seem to be sufficiently promising to justify a careful investigation of this plan.

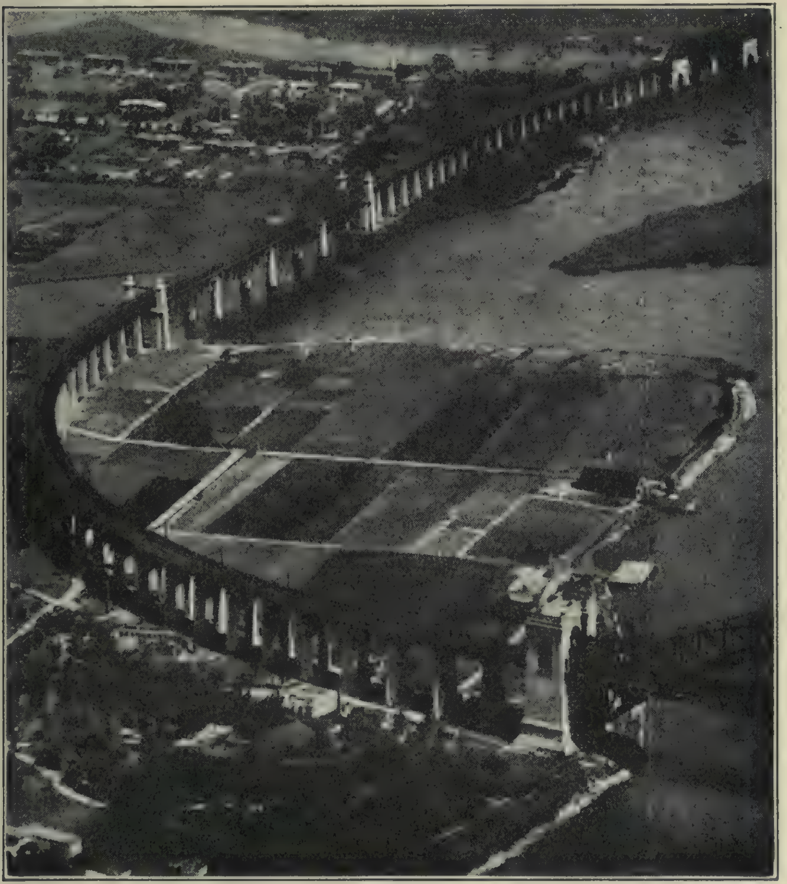


Fig. 3. Birdseye View of site of proposed treatment plant on Wards Island

As indicated on the accompanying cut, there is a corner of Wards Island cut off from the rest by the New York Connecting R. R. upon which a disposal plant could be most advantageously located. The land is vacant and of moderate elevation above tide level. No other such area is available in this vicinity.

Altho publicly owned its value for other purposes in this central location is such that an increasing demand for its occupancy seems inevitable in the near future, and if it were thus made unavailable for purposes of sewage disposal the city would, in all probability, be obliged later to expend a greatly increased sum to provide facilities elsewhere.

To conclude, it may be said that the situation regarding harbor pollution has received careful and continued attention for nearly 20 years; the main facts are known and recognized, and with the exception of the above problem relating to the Lower East River the general features of a plan for main drainage and sewage disposal for New York are pretty well defined. Progress in carrying out physical improvements was delayed here as elsewhere by the war, but what has been accomplished in recent years has been in line with the general plan, so that the city will not be called upon to abandon or reconstruct the work at a later date.

The Use of Fine Screens in New York City

The City of New York has five fine-screening plants located as follows:

1. At the Elmhurst Disposal Plant, Boro of Queens.
2. At the 32nd Avenue Outlet in Flushing, of Queens.
3. At the 43rd Street Outlet in Corona, of Queens.
4. At the 26th Ward Disposal Plant, Boro of Brooklyn.
5. At the Dyckman Street Outlet, Boro of Manhattan.

Those in the Boro of Queens are fixed plates, with ⅛″ x ½″ perforations, cleaned by hand, while those in Brooklyn and Manhattan are mechanically-operated Riensch-Wurl screens. There is also a screen of ¼-in. wire mesh at the Oak Street outlet in Flushing.

The two 14-foot screens in Brooklyn and their operation were fully described in a paper[1] read before this Society two years ago by George T. Hammond, Engineer in Charge of Experiments and Sewer Design, Bureau of Sewers, and a description of the Manhattan plant with a summary of tests made by the late Charles E. Gregory, representing the Boro of Manhattan, and the writer, representing the Board of Estimate and Apportionment of New York City, may be found in the Proceedings of the Society for 1919, as discussions of Mr. Hammond's paper. Views of the exterior and interior of the plant will be found on page 18 of that volume.

Further details of these tests may be of interest.

The Dyckman Street plant was built in 1916-17 at a cost, including grit chamber and submerged outlet, of about $83,700. There are two 14-ft. screens: one having 3/64″ and the other 1/16″ slots, housed in a brick building 48 ft. by 35 ft. in size. Their axes are inclined 20 from the vertical. Each screen has a nominal capacity of about 6 mgd. but the present dry weather flow is but half that amount. One screen, that with 3/64″ slots, is regularly operated, the other being held in reserve, and excess storm water is by-passed to the river. Each screen, with its brushes, is operated by a 2½-h.p. motor at a rate of ½ r.p.m. and is cleaned by the use of a hose for a few minutes about three times a day and spraying with from a quart to a gallon of petroleum with a watering pot once a day. This is found the best way to remove greasy deposits, which were found to occur to such an extent as to render 1/32″ slots ineffective. The plant is operated from 8 a.m. till midnight in two shifts, during which period the normal current consumption is 0.7 kw.

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[1] **Brooklyn, N. Y. Sewage Treatment Experiments.**

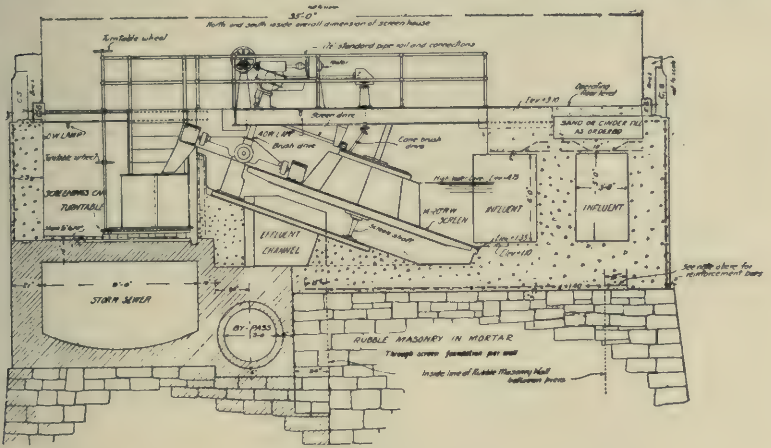

Fig. 4. Cross Section of Dyckman Street Screening Plant

There is a drop of a little over a foot from the screen to mean high water level. The screened sewage flows to a well and thence by a 16″ pipe 160 ft. long to an outlet in 40 ft. of water.

Screenings are dropped from the brushes into a can 24 in. in diameter by 24 in. deep to a perforated bottom which permits drainage water to pass off. Seven or eight cans full are collected daily and, after sprinkling with chloride of lime, are disposed of with the city's garbage.

Operation requires 2 men in the first shift and one in the second. Brushes wear at the rate of about 3/16″ per year and last between one and two years.

The tests above referred to were carried out in June, 1919. The flow was measured by a weir, the depth being recorded by a Friez float gage checked by direct measurement. The head lost in passing the screens was read on a board gage above the screen as compared with the float gage below the screen.

Tests of Screen No. 1, with 3/64″ slots, were made:

June	4, Wednesday	11:30 a. m. to 3.30 p. m.
"	5, Thursday	10:15 a. m. to 2:15 p. m.
"	9-10, Mon & Tues.	10:15 a. m. to 10:15 a. m.
"	12, Thursday	8:00 a. m. to 12:00 m.

Tests of Screen No. 2, with 1/16″ slots were made:

June	16, Monday	10:45 a. m. to 2:45 p. m.
"	18-19 Wed. & Thurs.	10:00 a. m. to 10:00 a. m.

Gages were read and samples of screened sewage taken every 15 minutes in all but the 24-hr. tests, when they were taken hourly between 10:15 p. m. and 6 a. m. and every 30 minutes the balance of the time.

Suspended and settleable solids in the raw sewage were determined by adding the amounts shown by analysis in the screened sewage to the amount, in parts per million, computed from the dried screenings and sewage flow. In this way, material errors which have occurred elsewhere in testing screens were avoided.

All tests were made during dry weather except that of June 9, when a sharp shower occurred between 12 and 12:30 p. m. A comparison with the results of other days fails to indicate any marked effect due to this cause.

Table I

Average Results of Tests in 16 4-Hour Periods

Rate of flow		1.74 mgd
Raw Sewage	—Suspended solids	143 ppm
	Settleable solids	103 ppm
Removed	—Suspended and Settleable	27 ppm
Screenings	—Moisture	80.2%
	Ash, dry basis	11.2%
	Volume per mg	20.4 cu. ft.
	Weight per mg	1128 lb.
	Weight per cu. ft.	55.9 lb.
Removal	—Suspended solids	19.7%
	Settleable solids	24.2%

The loss of head was very small owing to the small flow as compared to the screen capacity, the greatest average for any test being 0.39 ft. on June 12th. The difference between the two screens is brought out in the following table:

Table II

Loss of Head and Removal in Each Screen

Average of all 4-m. tests.

Screen	No. 1	No. 2
Slots	3/64″	1/16″
Flow	1.84 mgd	1.63 mgd
Head lost	.20 ft.	.04 ft.
Removal—Suspended solids	23%	16%
Settleable solids	31%	19%

This indicates that the screen with 1/16″ slots will remove about 7/10 as much material under these conditions as the screen with 3/64″ slots.

The night sewage was found to be abnormally weak and, probably owing to lack of colloidal matter, the percentage of removal was very high. The following table was therefore prepared, showing the weighted results with each screen separately when operating with day and night sewage. (Condensed from Table I of the writer's discussion of Mr. Hammond's paper.)

Table III

Tests of Riensch-Wurl Screens at Dyckman Street Plant, Manhattan, June 1919.

Average results, weighted in proportion to flow during the individual periods of observation.

Screen	Number 1		Number 2	
Width of Slots	3/64-inch		1/16-inch	
Day or night sewage.........	Day	Night	Day	Night
Crude Sewage				
Suspended solids p.p.m....	175	48	151	55
Settleable solids " ...	133	48	93	55
Screened Sewage				
Suspended solids "	139	21	129	46
Settleable solids " ...	97	21	71	46
Screenings				
Suspended sols. rem'd p.p.m..............	36	27	22	9
Moisture..............%	78	78	82	83
Volume cu. ft./m.g.......	27.1	9.5	18.4	9.2
Weight lb./m.g..........	1449	447	1040	447
Weight lb./cu. ft.........	53.4	47.0	56.5	48.6
Efficiency of Removal				
Suspended solids.......%	20.6	56.2	14.6	16.4
Settleable solids.......%	27.1	56.2	23.7	16.4

From this table the following conclusions are drawn:

1. With day sewage the 1/16″ screen removes about 1,000 lb. screenings and the 3/64″ screen about 1,300 lb. screenings per mg. With night sewage each screen removes about 400 lb. screenings per mg.

2. The efficiency of removal of suspended solids from day sewage by the 1/16″ screen is about 14% and by the 3/64″ screen 20%.

3. The removal of settleable solids from day sewage by the 1/16″ screen is about 23% and by the 3/64″ screen 27%.

With night sewage each screen removed about 400 lb. of screenings per mg. but the results were so erratic that it was not possible to draw conclusions as to the analytical results and efficiency. The removal of suspended solids, for instance, varied from 14.3% between 10 p. m. and 6 a. m. June 19th and 20th with the 1/16″ screen, to 92.5% between the same hours June 10th and 11th with the 3/64″ screen. This last extraordinary figure is probably due to the fact that the small amount of material removed consisted of sticks, rags, paper, etc., floating in water containing little finely-divided organic wastes.

So far as can be told by the above tests a removal of 20% suspended solids may be considered a fair general figure to assume provisionally in estimating the effect of fine-screening by 3/64″ Riensch-Wurl screens with fresh sewage of this character, while nearly 30% of the settleable solids should be removed, these, by the way, being those that are the more objectionable to sight and responsible for the larger part of the sludge deposits.

In May, 1920, samples of the Dyckman Street screenings were analyzed with the following results:

Table IV

Analysis of Screenings

Weight per cu. ft.	58 lb.
Moisture	68.2%
Total nitrogen, dry basis	2.25%
Loss on ignition, dry basis	73.8%
Ash, dry basis	26.2%
Fats (ether soluble), dry basis	21.1%
Phosphoric acid, dry basis	1.11%
Potash, dry basis	0.064%

The analytical work in both the Brooklyn and Manhattan tests was performed by W. T. Carpenter, Chemist.

SLUDGE HANDLING AT THE ROCHESTER SEWAGE DISPOSAL PLANT

By N. Adelbert Brown, Engineer in Charge of Sewage Disposal, Rochester, N. Y.

The sludge beds at the Rochester plants were designed on the generally accepted rule of one square foot for three persons, and under the local climatic conditions this area has proven satisfactory. The Irondequoit Plant handles combined sewage. The ten Imhoff Tanks are preceded by grit chambers and Riensch-Wurl screens and are designed to serve 200,000 persons. There are forty individual beds, each approximately 44 feet square. The tanks are built in double units with a common sludge trough. This trough is on the wall between two rows of four beds, allowing the sludge from any tank to be diverted to one of eight beds. The troughs have a slope of one in fifty, which gives a high velocity, and are nearly self cleansing. The sludge is discharged onto the center of the bed thru an 18-inch opening controlled by stop boards in the side of the trough. The sludge falls onto a concrete splash plate. A depressed channel extends transversely to the sludge troughs between the first and second and the third and fourth beds of each tier. This channel is four feet below the top of the bed and nine feet deep and nine feet wide. In this channel is laid a narrow-gage track for the sludge cars and on the walls are tracks for a gantry crane.

The beds are level and consist of 2 inches of fine sand, 3 inches of coarse sand, eight inches of gravel and 6 inches of broken stone. They are under-drained by 3-inch farm tile laid with open joints on eight-foot centers. These tile discharge into an open drain under the track channels.

The Imhoff tanks have two rings of perforated pipe in each hopper and the sludge is agitated each week. The sludge pipes are also blown out and left filled with clear water after each drawing. No cones are found in the sludge surface and no plugging of the pipes has been experienced.

Drawings are made during the season as often as the removal of the dried sludge permits. Nine inches of wet sludge are drawn on a bed. The drawing season is reasonably constant as shown by the following table:

Year	*First Drawing*	*Last Drawing*	*Period in Days*
1918	April 15th	November 15th	214
1919	April 29th	December 10th	225
1920	May 7th	December 21st	228
1921	March 24th		

While the season is nearly the same each year the number of drawings varies according to the weather. In 1920 each bed received nine fillings, an average of one every twenty-five days. In 1921, an extreme drought permitted seven drawings between March 24 and June 23, an average of one every 13 days with the longest drying period 22 days and the shortest 10 days. Up to August 10 four additional drawings have been made which gives a season's average to date of 12.6 days per bed.

To remove the dried sludge, two trains of six one and one-half yard Koppel cars are used. The trains are run in the depressed channel under the gantry crane which lifts the car bodies from the trucks and sets them on the bed and replaces filled bodies on the trucks. In loading cars stone-forks are used and the sludge lifted in cakes approximately 12 inches square. A few extra car bodies set on the beds permit the moving of trains without delaying the labor force. The trains are hauled by storage battery locomotives and the crane is electrically operated as power is developed at this plant from the effluent.

The usual force consists of one foreman, one hoist man, two locomotive runners and eleven laborers. Eight men do the loading, one is on each train to dump the cars and one is at the dump to keep the track clear. This crew will remove on an average two hundred cubic yards of loose dry sludge in eight hours. With labor at 50 and 55 cents and neglecting power costs, this sludge is delivered to the spoil bank at 33 cents per cubic yard.

During much of the season, the sludge is sold to farmers as removed from the beds. The cars are run to the tipple and dumped directly into the wagons or trucks. As the tipple is located further from the beds, the additional haul and delays in dumping increase the cost of removal ten per cent.

The sludge when drawn contains from 79 to 86 per cent of moisture. It is more dense in the first drawings each season and is thinner as the season progresses. At the time of removal the moisture is reduced to from 50 to 60 per cent. A rain on the beds after the cracking has occurred, packs the sludge so that it is difficult to reduce the moisture below 60% in any reasonable time. The shrinkage in drying is normally a little more than half of the wet volume. Analysis of a dry sample yields 2.2% nitrogen and 56.3% mineral matter.

Due to the depth of the tanks, the entrained air bubbles expand greatly when drawn onto the bed and make the dried sludge a light, porous cake.

The quantity of sludge varies, but the average for three years has been 1.151 cubic yards of wet sludge per million gallons. In a large plant the disposition of the dry sludge becomes a problem. Realizing this, the plant at Rochester started in 1918 to develop a demand for it as a fertilizer. During that time it was given to any farmer who would load and draw it away.

The plant is located in a fruit and truck garden section having a sandy loam soil. Reports of the use of this fertilizer were not enthusiastic. This was in part due to a belief that enthusiastic reports would increase the price. In 1919 a charge of 50 cents a load was made, the buyer loading from the dump, and more was drawn away than in the previous year with no charge. A proposal came from the farmers that with a more convenient method of loading they would pay a higher price. The tipple was erected and the price put at 75 cents per car, the car holding nearly two cubic yards. When sludge is not being removed, the dump is still open at 50 cents per yard. During 1920 the income from this source was $1,015.00. To July 1 of this year it has been $650.00. The income is small but the disposal of continually increasing quantities is preventing an accumulation on the grounds of the plant.

It is being hauled for distances up to five miles. In peach, cherry and pear orchards it is used as a top dressing spread around the trees. On the truck farms it is spread with fifty yards to the acre and ploughed under. The truck men use it under corn, tomatoes, celery, cabbages and melons. It is still impossible to obtain reports favorable to sludge, but the same farmers are drawing it after four years of trial and using more than ever before.

SEWAGE DISPOSAL FOR SMALL MUNICIPALITIES

By John F. Skinner, Principal Assistant City Engineer, Rochester, New York

The undersigned was chairman of a sub-committee of the Sanitary Section of the American Public Health Association which presented a report in September, 1920, on "Rural Sanitation." This report was confined to the disposal of water-carried sewage from single houses and small groups of not more than a few hundred people.

The present study is intended to cover villages and small cities.

One principle only may be postulated which will apply to all cases, viz: Each situation is a distinct problem to be studied and solved truthfully; always remembering that the truth upon any subject is obtained by marshaling all the facts in their proper relations.

In view of the above it may be helpful to outline the data to be considered, the conclusions therefrom, the resulting type of plant applicable, the elements of disposal plants and certain observations.

I. Data to Be Considered

1. PHYSICAL CONDITIONS.
    - A. *Area of Territory*
        - (a) Present
        - (b) Future
    - B. *Character of Territory*
        - (a) Compact or scattered
        - (b) Residential, commercial or industrial
        - (c) Flat or hilly, gentle or steep slopes
        - (d) Low, requiring pumping, or high, allowing gravity outfall
        - (e) Geology; sand, gravel, clay, quicksand, rock
    - C. *Population, Density and Total Numbers*
        - (a) Present
        - (b) Future
        - (c) Resident
            - a. Home and business
            - b. Home only (commuters)
        - (d) Nonresident (industrial)
        - (e) Seasonal (summer colony)
        - (f) Transient (summer resort)
2. SEWERAGE SYSTEM.
    - A. *Character of Sewer System*
        - (a) Separate
        - (b) Combined

- B. *Amount of Sewage*
  - (a) Dry weather flow } Obtained by:
  - (b) Maximum flow
    - a. Amount of water supply and population
    - b. Sewer gagings
    - c. Proportion of stormwater admitted in case of a combined system
    - d. Precipitation, run-off data, impervious, etc.
- C. *Character of Sewage*
  - (a) Domestic waste
  - (b) Industrial waste
    - a. Solids
    - b. Color
    - c. Odor
    - d. Source
    - e. Chemical constituents
    - f. Temperature
  - (c) Ground water
  - (d) Street wash (in case of combined system), quantity of manure, leaves, grit, etc., received thru surface sewers.
  - (e) Settleable and suspended solids with their settling rates
  - (f) Effect of various precipitants, especially in the case of preponderating trade wastes
  - (g) Oxygen demand—putrescibility

3. Body of Water Receiving Effluent of Plant.

- A. *Non-Potable, no Bathing*
- B. *Salt Water with Beaches to Protect*
- C. *Tidal Stream—Bathing*
- D. *Fresh-Water Lake*
  - (a) Bathing
  - (b) Water supply
- E. *Fresh-Water Stream*
  - (a) Large or small
  - (b) Riparian uses
  - (c) Industrial uses
  - (d) Bathing
  - (e) Water supply
- F. *State Regulations regarding Discharge of Sewage*
- G. *Currents*—Dilution and Dispersion
- H. *Deep or Shallow*
- I. *Constant or Variable Level*
  - (a) Fluctuation due to tides
  - (b) " " " precipitation
  - (c) " " " storage
- J. *Temperatures*—Water and Sewage
- K. *Wind—Prevailing Direction and Intensity*
- L. *Vegetation*
- M. *Pollution other than by this Effluent*

N. *Protection of Fish, Oysters, etc.*
O. *Visual and Aerial Nuisance*

4. FUNDS AVAILABLE FOR SEWAGE TREATMENT

II. Conclusions from the Data

1. VOLUME OF SEWAGE TO BE TREATED.
   A. *Dry Weather Flow—Present and Future*
   B. *Maximum Flow—Present and Future*
   C. *Distribution—Thru Day and Week.*
2. CHARACTER OF SEWAGE.
   A. *Variation in Density*
   B. *Solids—Settleable and Suspended*
   C. *Oxygen Demand—Putrescibility*
   D. *Color, Odor, etc.*
3. CHARACTER OF TREATMENT INDICATED.
   A. *Discharge into Non-Potable Water*
      (a) Remove floating and coarse[1] suspended objects
      (b) Remove grit where necessary to prevent deposits in stream, lake or long outlet pipe
   B. *Discharge into Small Non-Potable Stream*
      In addition to "(a) and (b)" above treat further sufficiently to prevent nuisance.
      (c) Remove settleable solids and 40 to 90% of suspended solids by tank treatment
      (d) Oxidize effluent
   C. *Discharge into Large Potable Stream or Lake where there is Ample Dilution and Oxidation.* Treat as in (a), (b) and (c). "(c)" may be omitted if the effluent does not appreciably affect the receiving body of water.
      (e) Disinfect the effluent when sewage pollution, possible from the effluent, can be detected near bathing beaches or water works intakes.
   D. *Discharge into Small Potable Stream or Lake*
      Treat as indicated in (a) (b) (c) (d) and (e) above

III. Type of Plant Applicable

The above operations may be accomplished respectively by means of the following devices:

(a) Remove floating and coarse[1] suspended objects—by coarse racks, fine racks or mechanical screens
(b) Remove grit—by detrius chambers
(c) Remove settleable solids and 40 to 90% of suspended solids—by tank treatment with or without precipitants
(d) Oxidize effluent—by irrigation, sand filtration, contact beds, trickling filters, or aeration or activation
(e) Disinfect the effluent—by liquid chlorine or bleach

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[1] Without entering into controversy as to the amount removable by screens, in this paper coarse solids are distinguished from fine in that the latter are best removed by sedimentation or precipitation.

IV. Elements of Disposal Plants

1. REMOVAL OF SOLIDS.
   - A. *Screening Devices*
     - (a) Coarse Racks: Bars 2″ to 4″ apart for large objects in combined sewage
     - (b) Fine Racks: Bars ¾″ apart for coarse floating and suspended matter in fresh sewage, when followed by tank treatment
     - (c) Fine Mechanical Screens: For coarse floating and suspended matter, particularly in the case of stale or septic sewage when followed by further treatment. The removal is mainly garbage. Also where no further treatment is required, as above in II-3-A and C.
   - B. *Detritus Chambers:* For the removal of grit and heavy (mainly inorganic) solids which will settle from a stream flowing at a mean velocity of one foot per second. This should precede fine racks or screens; more important for combined sewage.
   - C. *Tanks:* For the removal of settleable solids and 40% to 90% of suspended solids.
     - (a) Septic tanks, 8 to 12 hours detention
     - (b) Biolitic tanks
       - a. Agitation chamber 6 to 8 hours detention
       - b. Settling chamber 2 to 3 hours detention
     - (c) Imhoff tank
       - a. Flow chamber—3 hours mean detention for best removal
       - b. Digestion chamber—4 to 6 months sludge
     - (d) Settling tank—3 hours mean detention with continuous removal of sludge for separate digestion, with or without a precipitant.

2. OXIDATION OF EFFLUENT.
   - A. *Dilution* in lakes or streams.
   - B. *Broad Irrigation:* Only applicable under unusual conditions of isolation and cheap land.
   - C. *Sand Filters:* Only applicable where large areas of natural sand and gravel are available in suitable location.
   - D. *Contact Beds:* For locations so close to habitations that the spray from sprinklers would cause nuisance.
   - E. *Trickling Filters:* Of broken stone or brush. This is probably the best known method of artificial oxidation of tank effluent. When carefully designed and constructed they have been uniformly successful on well settled sewage which does not contain unusual elements, trade wastes, etc. They are expensive to construct but cheap to operate. They should be followed by settling basins for secondary sludge.

F. *Aeration or Activation:* The process known as "Activated Sludge" produces a well oxidized effluent by means of agitation and thoro mixing of sewage, air and previously aerated sludge. It is a plant relatively cheap to install but most expensive to operate. It requires less area than any other artificial method of oxidation but it is limited to situations where cheap power is available, where fertilizer can be produced as an offset to the expense of operation and upon a large scale. Certain adaptations still in the experimental stages offer promise of success.

3. DISPOSITION OF SOLIDS.
   - A. *Screenings*
     - (a) Incineration
     - (b) Composting for fertilizer
     - (c) Treated as garbage
       - a. Buried
       - b. Burned
       - c. Reduced
   - B. *Grit: Dumped for filling*
   - C. *Sludge*
     - (a) With or without digestion
       - a. Dumped in deep water or discharged during flood conditions
       - b. Lagooned or dried in furrows and covered
     - (b) With digestion—drained on drying beds and used
       - a. For fertilizer
       - b. For fertilizer base
       - c. For filling
4. DISPOSITION OF EFFLUENT.
   - A. *Direct in to receiving body of water*
   - B. *Through Long Conduit to avoid local pollution*
   - C. *Chlorination where necessary with*
       - a. Liquid chlorine or
       - b. Bleach

     To protect
     - (a) Water supply
     - (b) Shell fish
     - (c) Bathing beaches

V. Observations

There are certain details in the construction and operation of disposal plants which are too often overlooked, as they are generally omitted in the literature of the subject.

Provide the plant, where necessary, with:

1. Water under pressure
2. Industrial railway
3. Light
4. Heat in building for cold weather

5. Repair shop with forge, pipe cutter, stock and dies and bench tools
6. Laboratory and apparatus
7. Power for the above and other uses
8. Labor under competent supervision

The moving of sludge, grit and screenings is often most conveniently accomplished by an industrial railroad preferably operated by storage battery locomotives, as this method obviates the danger of exposed trolly wires.

In fortuitous situations like two of the present and two of the future plants of Rochester, N. Y., power is obtained from the fall of the sewage and fuel is only used for heating, otherwise it must be provided and becomes an important element in the expense of the plant.

A certain amount of labor may be effectively employed in hosing and washing down decks and walls, skimming tanks, agitating scum in gas slots by streams or by the use of tamps to prevent the formation of a continuous crust and afford free vent for the gas.

Labor is also required in operating gates, removing sludge, grit and screenings; raking over the surface of trickling filters when the first "ponding" appears, inspecting and cleaning spray nozzles daily as well as the distributing and collecting pipes.

Such operations are most certainly performed when a methodical schedule is maintained and directed by a responsible man on the job.

Flies in large numbers are disgusting around a disposal plant and can be largely avoided by reasonable precautions. As they come to obtain food, they can be discouraged by keeping all surfaces washed clean and by barring floating solids from quiescent water in tanks.

In the relatively rapid current of a detritus chamber in advance of screens, it is only necessary to keep the walls washed clean. Grit from a properly operated detritus chamber will not attract flies, neither will well digested Imhoff sludge, whether wet, spadable or dry.

Fine screens and efficient scum boards, hosing and occasional skimming will minimize the floating solids in a settling tank, or reduce them to such size that they will not support a fly.

Screenings attract flies as they are largely composed of garbage. They should be covered with grit, earth or ashes or compacted and sprinkled with borax solution.

Small moth flies which are found in warm weather on and above a trickling filter come from the larvae resident on the stones just below the surface. They do not travel far from the filter and are not objectionable. They may be kept out of other portions of the plant by screening doors, windows and other openings, and by providing curtain walls dipping below the surface of the sewage.

Odors. The best plan is to surround the plant by a large tract of land municipally owned and controlled, but even then certain odors which reach to considerable distances may produce nuisance unless controlled.

Well digested Imhoff sludge is not objectionable and can be noticed only in the immediate neighborhood. Odor from screenings can be controlled by covering as suggested above. Liquid sewage when undisturbed does not give much offence, but when it is broken up in rapid currents by means of baffles, or tumbled over weirs, it becomes more noticeable.

Odors have been found objectionable at distances of half a mile when sewage is blown into the atmosphere as spray, by air under pressure.

This nuisance does not occur when the wind direction is unfavorable, nor yet when there is perfect quiet. A strong wind or good breeze does not seem to cause trouble to leeward for the vapor is too attenuated when mingled with a considerable volume of air. Smells seem to be carried furthest with a scarcely perceptible drift of the air.

The remedy for this condition consists in covering so that rising spray or vapor will impinge upon the under surface of the cover and be condensed.

At the main (Irondequoit) sewage disposal plant of Rochester, N. Y., where the total cost, including the site of 315 acres on the shore of Lake Ontario, was $975,500, and where 45 feet head is available most of the time, the cost of accessories such as water works, railroad, grading, light and power was $108,000.

In general such accessories, including equipment of shop and laboratory, may amount to 10 or 15% of the cost of the plant.

MISCELLANEOUS PROBLEMS CONNECTED WITH THE DESIGN AND MAINTENANCE OF SEWERAGE SYSTEMS

By Milton J. Ruark, Division Engineer of Sewers, Baltimore, Md.

The design and the maintenance of a sewerage or drainage system are two distinct and independent functions. Usually the engineer responsible for the designing is especially trained in this particular branch of engineering; is qualified to make the necessary surveys and calculations, and can execute detailed plans and specifications to the satisfaction of the State Board of Health or other authorities. Unfortunately, however, the consulting or designing engineer seldom has the opportunity to operate and maintain the system which he has planned. His knowledge of maintenance problems is, therefore, mostly obtained from others and is not his own experience. It is, therefore, to be expected that he will not be able to anticipate all of the maintenance difficulties, some of which may be due to local conditions, and the burden of successfully operating the system must be solved by someone else who may or may not be particularly qualified and may have no knowledge of the principles involved in the original design. If the engineer has exercised ordinary skill and given sufficient thought and study to the subject so that the proper and most suitable system is adopted; if designs are prepared and detailed in an accurate manner; and, furthermore, if the plans and the specifications have been followed out by the engineer in charge of the construction, it is safe to say that maintenance problems should be few, and of such a character that only minor modifications to the system will be required, and the operation cost will therefore be small.

On the other hand, maintenance problems are often numerous, difficult to correct, and involve unreasonable up-keep charges because the sewerage system has been either poorly designed, or as is more commonly the case, constructed in a haphazard manner without sufficient engineering supervision. Where the designing engineer of the system is one who is familiar with the maintenance problems, he will, of course, avoid many errors and pitfalls that he has become aware of thru experience.

The sewerage and drainage system of Baltimore, approximately 90% of which was built between the years 1906 and 1916, has now been in service about 10 years. At the time when preliminary plans were submitted and approved, there was much difference of opinion as to the best methods of design to follow. In a great majority of instances it is clear and beyond dispute that the designs of the engineers, adopted and carried out in detail, were the best ones, altho there are a few cases where equal or better results might have been obtained by using some other and perhaps less expensive method.

Unobstructed and Clean Sewers

One of the chief results to be obtained by the sanitary engineer is a sewerage system that will be free of obstructions, chokages and foul odors, and which can be kept in this condition by ordinary maintenance labor. The prevailing impression is that if the grades of the sewers are sufficiently steep no trouble will be experienced with deposits forming in the sewer. The problem, however, does not end with the designer. He may have provided for sufficiently high velocities, and nevertheless when the sewer is put in service obstructions will frequently occur especially if good construction work is not insisted upon.

More important than good grades is a selection of good quality pipe, and skilful pipe laying. Pipe must be smooth, straight, and in continuous alinement thruout without the irregularities and kinks which so often occur, due to the interference of other underground structures. Each joint must be made as tight as practicable, and the well established principal of straight horizontal and vertical alinement between properly spaced manholes must be observed. One of the chief causes contributory to obstructed sewers is tree roots. Where skilful pipe layers are employed, and good tight joints are made, the probability of an obstructed sewer from this cause is reduced to a minimum. Roots from the common poplar tree are responsible for most of the trouble in Baltimore, and occur more frequently in the house connection than in the lateral sewer. This trouble, however, has not been experienced in storm-water drains, and is probably accounted for by the fact that small drains carry little or no flow during dry weather. Even where bituminous compound joints have been used as a precaution against tree roots, they have found their way into the sanitary sewers. It is a recognized fact that poplar trees have little value as shade trees, and that the roots also cause failures in cement or brick sidewalks. For this reason an ordinance has been passed in this city prohibiting the further planting of this species of tree. The demand and market for many of the complicated mechanical sewer-cleaning apparatuses, so widely advertised by manufacturers, is due to the fact that many municipal sewerage systems in this country have been poorly designed and constructed.

Plumbing an Essential Part of the Sewerage System

When the sanitary sewerage system of Baltimore was put in service, each building, premise, and establishment was required to be connected to the sewerage system at the expiration of

60 days after being notified by the Health Commissioner. The regulations required that the existing plumbing be made to conform with a revised plumbing code under which all wastes of a polluted character were required to be disposed of into the sanitary system, and rain water or other non-polluted waste into the storm-water system. Rain leaders, which were permitted to be discharged upon the surface, were connected to the storm-water system at the option of the property owner. These regulations were enforced in all instances, even where a building was connected to a private sewer, and considerable money had to be spent in rearranging existing plumbing to conform to the new regulations. In cases where property owners failed to comply with this notice within a reasonable time, the health authorities had the power to make these connections to the city system, and the cost of the work became a lien upon the property. Where the property owner was not able financially to do this work, the city also arranged to have the work done by the owner's plumber, the owner paying the cost, with interest, in five annual installments. The rigid enforcement of the above regulation; the elimination of all cesspools and old outside running traps, which are still in use in many cities, has done much to improve sanitation in Baltimore. Notwithstanding that the reconstruction of the house plumbing and the cost of making sewer connection has involved an expenditure, according to the least conservative estimate of $8,000,000 on the part of the property owners, it has been demonstrated that the benefit derived has justified the course taken by municipal officials. In the business districts the majority of down-spouts are connected directly to the storm-water drainage system. The practice of making separate connections to the storm-water system has increased, and it is a question whether it is not better to provide a separate connection in order to dispose of all water from roofs, area-ways, subsoil drainage, and water from garage floors. If this practice were followed, large quantities of rain water would be eliminated from the surface of streets; but some authorities claim that it is better to discharge water on the surface, as it tends to keep the streets in a cleaner and more sanitary condition.

Catch-Basins

With the exception of a few low-lying drainage areas there are no catch basins in Baltimore, and it is not likely any will be built in the future. Most of the storm-water drains are self cleaning; and the building of catch basins would therefore serve no useful purpose, but would probably become a nuisance. Catch basins are very expensive to clean out. They soon fill up with silt, and it is difficult if not impossible to prevent street sweepers from disposing of street sweepings in these inlets in order to lessen their labor. Furthermore, catch basins often retain a good deal of decomposed matter, and they cause complaints because of odors, and prevent a free circulation of air thru the drainage system.

Manhole Covers

Altho the design of manhole covers would seemingly play an unimportant rôle in sewer design, there is room for much improvement along this line. Where the separate system is used, covers for sanitary sewer and storm water drain manholes should be clearly marked with such words as "Sanitary Sewer" and "Storm Drain" so that all municipal employees can tell the kind of sewer without taking the cover off. A penalty should be imposed for removing these covers, and the amount of the fine should be marked on the cover. Where the separate system of sewers is used, the manhole frames and covers should not be of the same size for both systems. Unless the covers are of slightly different diameters they will be interchanged and cause much confusion in maintenance work. For example, snow is likely to be dumped into sanitary manholes under the impression that it is being disposed of into the storm-water drains, which practice causes much trouble.

During the early days of the Baltimore Sewerage Commission six holes, each one inch in diameter were provided for in the top of manhole covers for ventilation and for removing them. As the sewers get ample ventilation thru the house stacks this number was reduced to two without any ill effects. Were it not for the fact that some means have to be provided to take the covers off, no holes would be put in them at all. A good deal of ground water would thus be eliminated from the sewerage system which is treated at the sewage works.

Complaints have been made because of loose manhole covers which rattle when traffic passes over them. Experience at Baltimore has shown that the best way to remedy this condition is to have all manhole frames and covers inspected at the foundry. Only those castings that fit well are selected. They are bought by the city, and furnished to the contractors who are building sewers.

Lampholes and Stand Pipes

Altho lampholes were built on the sanitary sewers of Baltimore when the system was first installed, this practice has since been discontinued. They are a source of trouble as mischievous children remove the lamphole covers with little difficulty, and drop sticks and rubbish in the sewers, which become choked. If sewers become obstructed, lampholes are of little or no value in clearing them, and it is seldom that they facilitate maintenance work in any manner whatsoever. Furthermore, even when carefully constructed the lamphole will frequently settle and break away from the lateral sewer due to unequal settlement. House connections, which are made from deep sewers by means of stand pipes, are also a source of many troubles due mostly to settlement.

Garage Connections

It is unlawful in Baltimore to connect garage floor drainage to the sanitary sewers. Thus one of the main causes for gas explosions in sanitary sewers is prevented, altho explosions have caused serious accidents in many cities. There is no record of explosions in any of the Baltimore sewers. It is permissible to connect garage drainage to the storm water drains, but the plumbing regulations require that an approved trap of ample capacity be installed on the house side of the sewer connections so as to intercept any gasoline or oils that might otherwise flow into the storm-water drain.

Flush Tanks and Flushing Connections

One and one-quarter-inch taps from the water mains of the city were originally extended to each terminal or dead-end manhole in order to flush out the sanitary sewers as the occasion required. The practice of installing these taps has also been discontinued as it has been demonstrated that only occasional flushing is necessary, and that the connections often rust out and become leaky in a short period of time. For similar reasons the use of flush tanks has been limited to serve sewers which are laid on very flat grades, and their use even under these circumstances is questionable. Moreover, there have not been many complaints of deposits in sanitary sewers that are at or near the end of the lines.

In Baltimore four men spend all their time in making periodic inspections of all manholes. They remove from the manhole benches such things as sticks, rags, bottles and other material that might choke the sewer. Often they find that some sewers are partially obstructed, and they immediately have these obstructions removed. This work reduces the amount of money expended in cleaning the sewers, and at the same time there are fewer complaints from property owners because of flooded cellars.

Sewage Pumping Stations

A gravity system of sewers should be installed whenever it is possible so as to reduce pumping to a minimum. The design of a pumping station, either large or small, requires very careful consideration and a vast amount of detail work. Extreme caution must be exercised that the proper type of mechanical and electrical equipment is selected. Ample space for units to meet future requirements must be provided, and reserve units must be installed in case of a breakdown. The average daily flow at the main pumping station in Baltimore is 25,000,000 gallons, and the maximum flow has at times reached 38,000,000 gallons per day. Nevertheless, this station has been in continuous service without interruption, and the successful operation of a station of this size is assured if the equipment is first class, kept in good repair, and a competent, reliable staff of power-plant operators is provided. That pumping stations of both large and small capacities can be located in congested districts without becoming objectionable to adjacent property owners, and further that sewage screenings can be disposed of by incineration within the pumping station without causing a nuisance, has been clearly demonstrated by the operation of such a station in Baltimore.

Sewage Treatment

One feature of sewage treatment that has demonstrated itself is that it is practically impossible to eliminate complaints because of odors from a large plant. A sewage treatment plant of any size is bound to give off odors and the engineer who claims that he can eliminate them altogether will be disappointed when he faces actual operation conditions. Theoretically a certain method of sewage treatment may be used without producing odors, but when all weather conditions are encountered, when wide variations in sewage flow occur, and when the plant is operated by poorly trained men who are negligent, aerial nuisances almost invariably arise. Very often complaints from odors are unfounded or are exaggerated. Human psychology is such that people who live in the vicinity of a sewage treatment plant often imagine that they get odors from the plant when such is not the case. Where the land can be bought at a low price, it is advisable to buy a large tract as was done at Baltimore in order to isolate the plant, and reduce the number of law-suits which are bound to follow. After the plant is built, any land bought in the vicinity of the plant can be resold with the provision that the purchasers will not enter suit against the municipality.

Conclusions

Within the past 10 or 15 years great advances have been made in sewer design. The rational method of designing storm water drains has been introduced. The separate system is becoming more firmly established. A great deal of information has been compiled as to the hydraulics of sewers, and much other valuable data have been obtained. But much remains to be done. Engineers should ascertain with a greater degree of accuracy the value and advisability of using concrete for sewers as compared to terra cotta vitrified earthenware pipe, the effect of various kinds of sewage and industrial waste flowing under different velocities and conditions both in concrete and brick lined sewers, and the life of these materials under such conditions. Engineers should as a matter of public service make a more detailed study of the storm-water run-off from various kinds of pavements, etc., the percentages of water entering different types of inlets under varying surface grades and conditions. It is true that engineers have not learned the last word pertaining to the design and construction of sewers, but much ground has been covered. The most fertile field for investigation and research in sanitary science lies in the field of sewage treatment, and it is not unlikely that within a few decades our present methods of sewage treatment will give place to other methods, which are more economical and efficient.

REPORT OF SUB-COMMITTEE ON PUBLIC COMFORT STATIONS

Harry F. Bascom, C. E., Chairman, City Engineer, Allentown, Pa.

A comfort station is a public convenience. A public convenience is the community use of a personal human necessity. It is the plain common-sense recognition of the needs and the functions of the human body, in health and disease on the public highway.

Just why the various municipalities of this and the other civilized countries do not more readily comprehend these plain facts is not so much a matter of amazement as it is a matter of indolence. In the so-called "good old days" a great deal was said about the viciousness of the saloon and hotel bars but they served a partial purpose and a famous barkeeper was quoted to the effect that the toilet rooms drew as much trade as perhaps the free lunch or even perhaps as much as the wet goods on tap. Both the saloon and the free lunches are memories of the past and the passing of the former seems to press the lack of comfort stations to the fore more than any other factor.

Many cities are now waking up to the fact that one of the foremost public duties that can not be further overlooked if the city is to progress is to provide Comfort Stations or Convenience Stations as some municipalities prefer to have them called.

Many years ago European and British cities established comfort stations. Of the stations now in operation in London, Amsterdam, the German cities of Frankfort-on-the-Main and Berlin and also Paris, Berlin may perhaps be said to be ahead of all the others both in the number of the stations and in their convenience, as they are located in the retail business districts either under the beds or surface of the streets or in the public squares or circles, conveniently marked, well kept and always supervised by capable attendants. London's few stations are principally located underground and are generally poorly marked. The equipment in the London stations seems to be somewhat antiquated but the equipment in Berlin seems to be all of modern type.

The municipal authorities at Paris seem to have recognized the needs of stations for men only. The stations are numerous, located at frequent intervals along the sidewalks of the main boulevards, but are quite unsanitary and objectionable. Why the women are not afforded equal convenience to the men seems to be unexplainable and even in the public buildings their necessities do not seem to have been considered equal to those of the men.

Possibly the original comfort station idea originated in Philadelphia, for about 1821 Benjamin Franklin and another prominent citizen set aside a certain sum to be expended after a period of one hundred years "to provide a place for the convenience of strangers coming to our town."

The United States leads the world in sanitation, in fact most of the modern sanitary equipment is particularly an American development, but so far along this particular line progress has been rather slow and quite spasmodic. Perhaps this may be due to the fact that efforts have been along the line of individual initiative and enterprise rather than the outcome of some one or more larger organizations. The conviction is however rapidly growing thruout the country that provision for public comfort stations is a public duty and a State and municipal function.

The credit for establishing the first municipal public comfort station of any kind is claimed by New York City. This station was opened at Astor Place in May, 1869, as a result of more than twelve years of effort by sanitarians in that city. It was a miserable apology for a comfort station, as is now known, and it was soon abandoned.

The public comfort station movement seems to have been sleeping since that time until comparatively recently and we may possibly hand the laurels and the palms to our Mr. Volstead for so suddenly causing the renewed activities. Prof. W. T. Sedgewick, an eminent public health authority, in his annual presidential address (1915) before the American Public Health Association said that "probably the most flagrant failure in American sanitation to-day is the almost universal lack of public convenience or comfort stations in American cities and towns. Failure to provide public toilet facilities in our towns and cities is to fail in one of the very elements of public health service."

Since the above declaration more than fifty of our American cities have installed public comfort stations and additions thereto in appropriate form with various equipment and generally in desirable locations, and at least one State of the Union, (Wisconsin) has authorized by act of its legislative body that the various municipalities within its borders shall provide adequate public comfort conveniences. In the State of Pennsylvania an act was passed by the Legislature of that State and was approved by the Governor July 8, 1919, which Act provides as follows: "That the County Commissioners of any County may appropriate money to assist any city or boro, being the county seat within the boundaries of such county, to construct and maintain comfort stations.

In a recent nation-wide survey of the public comfort station situation it is noted "Allentown, Pa. and Atlanta, Ga. are two cities having the very finest types of up-to-date public comfort stations and their erection was made possible thru the financial help of the county authorities. In this survey a questionnaire was sent to every city in the United States with a population of 25,000 and over, and one hundred and twenty (120) replies were received. Sixty seven (67) or 56% were provided with public comfort stations of various kinds and locations and all totaling

173, or an average of 2.60 to each city. Twenty-nine (29) cities have one (1) station only, eighteen (18) have two, five (5) have three, four (4) have four, two (2) have five, one has six, three (3) have seven, one has eight, two (2) have ten, and one has twelve stations. Thirty-one (31) cities or 26% report plans under consideration while of the remaining 74, forty-two (42) cities or 35% report that for various reasons, lack of funds, etc. no stations are projected. Fifty-three (53) cities or 44% report no comfort stations whatever.

During the years 1919, 1920 and 1921 various stations were constructed in several cities of the country, among the more elaborate ones being at Portland, Ore. where three (3) stations costing $47,000 each were built. At Minneapolis, Minn., one was constructed at a cost of $37,000; Allentown, Pa. one costing $42,000; San Francisco, Cal. one at $33,000; Atlanta, Ga. one at $30,000; Asheville, N. C. one at $28,000; Detroit, Mich. one at $22,000; Jackson, Mich. one at $20,000 and one at Syracuse, N. Y. at $55,000.

In another survey by Mr. E. S. Rankin, one of the members of our committee, in the interest of his home city (Newark), a questionnaire was sent thru the Clearing House of Information of this society to a large number of cities and towns and replies were received from 95 of these. Thirty-nine (39) cities report no comfort stations. Included in these are such large cities as Philadelphia, New Orleans, Milwaukee, altho it is quite probable that these cities have stations in their parks which were not reported.

It is very difficult to make comparisons between cities on this subject as conditions vary so widely. The number of stations in any city does not seem to be as important as the location of the station in that city. Chicago reports 157 stations or one to each 17,000 inhabitants but only six of these are located in the congested business district. Providence, R. I. with only two stations or one to each 118,500 inhabitants seems to be much better provided for. Newark, N. J. reports 13 stations including those located in the parks, but only one of these is near the center of the city. At least four railroad stations provide conveniences in Newark's business section, which probably causes that city to be better equipped than almost any other city reporting.

There is perhaps a wider variation in the types and character of public comfort stations than in any other form of public improvement. In its simplest form, found frequently in city parks and public squares, it may consist of the simplest enclosures possible consistent with privacy and with accommodations for one or two persons at a time. The other extreme is the elaborate building, a typical example of which is found in Forest Park, St. Louis, containing in addition to toilet facilities, rest rooms, telephone booths, bootblack stands, and concessions of various kinds. Intermediate between these two extremes are types of more o less elaborate construction and furnishings.

The underground station seems to be the type most frequently adopted, the idea probably originating in an attempt to make the place as inconspicuous as is possible. Another reason is on account of the saving of valuable space above or at the street surface. As the problems of drainage and ventilation are much greater in the underground stations, this committee feels that stations below the surface should be avoided where locations above or at the street surface are available. If it be conceded that the public comfort stations are a public necessity it would seem to be an unnecessary refinement to attempt to conceal them or their location.

Trenton, N. J. is solving its comfort station problem by purchasing a building in the center of its business district, remodeling a part of the first floor for a comfort station and renting for various purposes the remaining part of the building.

Cost, Maintenance and Service

It follows from the above that there is necessarily a wide variation in the cost of the various stations, depending on the type adopted. In the replies received from the society's questionnaire the costs varied from $1,020 to $55,000 and above. Comparatively few figures have been obtained on maintenance costs. There are so many factors entering and so many local details that comparison is difficult.

Costs of light, heat, power, and supplies vary greatly with the locality and again vary greatly on the different days of the week and also with the different seasons. Where, as in Allentown, Pa., shower baths are provided, the cost of gas for water heating is at its maximum during the warmer months but at the same time the revenues are correspondingly greater. Here at this station is noted an absence of coal bins, heating equipment, ash receptacles, etc. the heating for the station being obtained from a central steam heating company whose pipe lines were located just outside the walls of the station.

To maintain proper sanitary conditions it is quite essential to have at the station at least one male attendant and one female attendant on duty for each shift. In the figures received for attendants the annual costs ranged from $1,200 to $8,300.

Out of the 57 cities reporting comfort stations, in answer to our questionnaire, only 12 receive any revenue therefrom, and in most cases it is almost negligible. The only city in which the receipts approximate the maintenance costs is Providence, R. I., where one station shows annual receipts of $9,212 as against a maintenance or operating cost of $8,330. This station is exceptionally well located in a central square and in the basement of a trolley waiting room. A ten-cent fee is charged for the pay toilets and $950.00 was received from the telephone concession. The other Providence station showed receipts of $5,133.00 for the year. The nearest approach to this is at Indianapolis with receipts of $2,000 and expenditures of $4,000.00 per year. From these figures the revenues diminish down to as low as $100.00. With telephone booths, vending and weighing machines and bootblack and newspaper stands and with careful supervision, providing that the station is properly located, the revenues should at least approximate the expenditures if not exceed them. The revenues from the Allentown, Pa., station, where there are located three shower baths at twenty-five cents per bath, one private room at ten cents and five pay toilets at five cents, also with telephone and scales in the men's department and one rest room at twenty-five cents, two at ten cents and three pay toilets at five cents each, also with telephone and scales, also sanitary napkin vending machines in the women's department, amount for a year to about $200 while the expenses amount to about $400.

Standard Comfort Station Signs

The standard sign, a four-pointed, orange-colored star inside a green circle all on a circular sign ten inches in diameter and with white enameled background is now adopted by the American Society of Sanitary Engineering, by the States of Wisconsin and California and by several cities of the country. The standard sign should be adopted by all of the states and cities and should be used at all comfort stations and at the entrance to all rooms where public comfort conveniences are provided. Railroad officials, department store managers, county and city officials should be urged to place these standard signs so that the public may become familiar with the meaning of the sign. We would recommend that this sign be officially approved by this Society. We would also recommend that all cities adopt the policy of providing adequate toilet facilities for men, women and children in all public buildings and having them so located as to be readily accessible to the public. In this way large sums of money for special buildings can be saved.

REPORT OF QUESTIONNAIRE SENT OUT BY THE AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS

Public Comfort Stations

City	*In Parks*	*Under Streets and Sidewalks*	*Elsewhere*	*Population*
Los Angeles, Cal.	2	0	0	600,000
Pueblo, Colo.	2	0	0	42,900
Savannah, Ga.	2	0	0	63,200
Chicago, Ill.	151	3	3	2,700,000
Peoria, Ill.	1	0	0	115,000
Waukegan, Ill.	1	0	0	19,226
Joliet, Ill.	4	0	0	40,000
Indianapolis, Ind.	4	0	0	315,000
Davenport, Iowa	5	0	2	60,000
Iowa City, Iowa	1	0	0	12,000
Creston, Pa.	2	0	0	8,800
Wichita, Kan.	8	0	0	73,000
Salina, Kan.	2	0	1	15,500
Columbus, Kan.	2	0	0	3,500
Louisville, Ky.	2	0	0	234,000
Baltimore, Md.	5	0	0	558,500
Boston, Mass.	77			748,000

City	*In Parks*	*Under Streets and Sidewalks*	*Elsewhere*	*Population*
Worcester, Mass.	One in every park		1	175,000
Benton Harbor, Mich.	2	0	1	12,500
Kalamazoo, Mich.	0	0	1	50,000
Grand Rapids, Mich.	1	0	1	140,000
Minneapolis, Minn.	0	7	0	400,000
St. Paul, Minn.	1	0	0	236,000
Kansas City, Mo.	12	1	1	324,000
Elizabeth, N. J.	1	0	0	100,000
Newark, N. J.	1	0	0	415,000
Atlantic City, N. J.	0	3	0	50,000
Trenton, N. J.	1		1	119,000
Elmira, N. Y.	0	2	0	43,395
New York, N. Y.	A number of them.			6,000,000
Rochester, N. Y.	In all large parks.		0	296,000
Batavia, N. Y.	0	0	1	14,000
Syracuse, N. Y.		2		
Asheville, N. C.	1	0	0	30,000
Dayton, Ohio				153,000
Lorain, Ohio	1	1	0	38,000
Columbus, Ohio	13	2	0	237,000
Cleveland, Ohio	10	0	1	850,000
Akron, Ohio	0	2	0	208,000
Chester, Pa.	0	0	1	58,000
Allentown, Pa.	2	1	0	80,000
Reading, Pa.	4	0	0	107,000
Bradford, Pa.	1		1	
Pittsburg, Pa.	27	4	5	594,000
Providence, R. I.	0	2		237,000
Sioux Falls, S. Dak.	1	0	2	26,000
Memphis, Tenn.	One in each principal park.			165,000
Nashville, Tenn.	1	0	0	120,000
Austin, Tex.	4	0	2	34,800
Waxahachie, Tex.	0	0	1	7,958
Houston, Tex.	4	0	1	138,000
Dallas, Tex.	22	4	0	158,000
San Antonio, Tex.	5	0	6	162,000
Salt Lake City, Utah	1	2	0	118,000
Norfolk, Va.	0	0	1	116,000
Ottawa, Can.	4	12	2	110,000
Toronto, Can.	16	4	5	512,812

Cities Reporting No Stations

City	*Population*
Troy, Ala.	5,700
Birmingham, Ala.	178,300
Florence, Ala.	10,500
Wilmington, Del.	110,100
Lakeland, Fla	7,000
Augusta, Ga.	52,500
LaGrange, Ill.	6,500
Woodburn, Iowa	
Sioux City, Iowa	71,200
McPherson, Kan.	
Shreveport, La.	43,900
New Orleans, La.	387,200
Lewiston, Me.	
Rockport, Mass	
Fairbanks, Mass	
Concord, N. H.	22,100
Bloomfield, N. J	22,000

West Orange, N. J.	15,600
Plainfield, N. J.	27,700
New Rochelle, N. Y.	36,200
Charleston, N. C.	
Winston-Salem, N. C.	48,400
Lakewood, Ohio	41,700
Canton, Ohio	87,000
Tulsa, Okla	72,000
Harrisburg, Pa	75,900
Philadelphia, Pa	1,823,100
Erie, Pa	93,300
Pawtucket, R. I.	64,200
Columbia, S. C.	37,500
Pierre, So. Dak	
Longview, Tex	5,700
Newport News, Va	35,600
Berkeley, W. Va	
Milwaukee, Wis	457,100
Beloit, Wis	21,300
Manitoba, Can	
Havana, Cuba	361,000

Cost, Maintenance and Revenues

City	*Cost*	*Maintenance*	*Revenues*	*Remarks*
Los Angeles, Cal		$5,593.00	$1,472,00	Average of 3 stations
Chicago, Ill	$25,000			
Waukegan, Ill	1,200			
Indianapolis, Ind	15,658	4,000	2,000	
Minneapolis, Minn	47,000			
Boston, Mass	10,700		1,102	Av. of 3 stations
Atlantic City, N. J.	23,421.00	5,854.00	1,455.00	Av. of 3 stations
Newark, N. J.	18,500.00	6,000.00	180.00	
Trenton, N. J.	69,340.00	4,200.00	700.00	Based on 3 mos. operation excl. of rent
Batavia, N. Y.		1,600.00		Rented building
Dayton, Ohio	17,500.00	3,580.00	130.00	
Cleveland, Ohio	10,000.00			
Allentown, Pa	43,832.00	4,200.00		Based on 7 mos. op.
Pittsburg, Pa	15,000.00		90.00	
Providence, R. I.	24,500.00	8,330.00	7,267.00	Av. of 2 stations
Salt Lake City, Utah	11,660.00	1,200.00	Very Little	Av. of 2 stations
Ottawa, Can	50,000.00	5,200.00	25–50	

DISCUSSION

A MEMBER: What did your station cost you?

MR. BASCOM: About $42,000. We did not feel we could raise $42,000 in the city for that purpose, so we had a bill introduced at Harrisburg, authorizing or permitting the County Commissioners to help. They had exhibited a great willingness to assist in paying for the station which they could not legally do. The bill was vetoed by the Governor. We had it modified and locations limited to cities and boros which are county seats only, and the bill was then approved by the Governor and the County Commissioners paid $20,000 towards the construction.

A MEMBER: What is your cost of maintenance?

MR. BASCOM: Our revenues are about $200 a month and cost of operation about $400. We have a man attendant and two ladies, and a boy operating the shoe-shining establishment. We don't expect and we don't think it should be expected that the revenues should equal the costs. We are not figuring any interest on investment. We are furnishing it for the public convenience. It is kept open from 7 a. m. until 11 p. m.

A MEMBER: Do I understand that towels are dispensed with entirely?

MR. BASCOM: They are there if you want to use them, but they are used very little. At the bath we furnish a paper towel and hot water for 25 cents. The attendant has a small towel which can be procured for five cents or a large towel for ten cents. The attendant gets that fee himself. We don't pay the attendant any wages. For the ordinary lavatory they use the drying machine. We have a case of paper towels on the wall but they are very little used.

CHAIRMAN RANKIN: I happened to be on this committee with Mr. Bascom and also on a committee in the city of Newark to look into the same matter. I visited a number of cities looking at comfort stations, and I want to say that Mr. Bascom has reason to be proud of his station in Allentown. It was the finest station I saw during investigations.

There was one recommendation made in the report that I consider very essential; that the sign should become the universal sign. It has no special significance that I know of, but it has been recommended, I believe, by one city and adopted by at least two states. We don't want a duplication of those things. I think it would be a decided advantage if every city in the United States adopted this sign so that every one when they see it would know what it meant. I would like to entertain a motion that this Society approve that sign as the standard public comfort station sign of the United States. (*Carried.*)

RETENTION OF PORTION OF ESTIMATES ON CONTRACT WORK

By E. S. Rankin, Engineer Bureau of Sewers, Newark, N. J.

On all sewer contracts entered into by the City of Newark a bond is required in the full amount of the contract and a deduction of 20% is made on all monthly estimates. (Up to the beginning of the year 1918 this deduction was 25%.) In addition to this, 5% of the final estimate is retained for one year and 3% for two years.

It has seemed to the writer for some time that these retentions were excessive, entailing an unnecessary hardship on the contractor and also an additional expense to the city, for the interest on the sums retained must, if the contractor knows his business, be added to his bid price, together with the cost of his bond.

To take a concrete example: The contract price of a certain sewer constructed last year was $117,687.50.

Cost of bond (1½% of bid)		$1,765.30
Interest on retained percentages on monthly estimates	$405.64	
Interest on retained percentage on final estimate	575.36	981.00
Total		$2,746.30

or about 2.3 percent of the bid price.

Is this or is it not too much to pay as insurance for the satisfactory completion of the work?

For my own information and not with the idea of presenting a paper to the Society I recently requested our Secretary to send out a questionnaire in order to learn how other cities treated this matter, including also similar questions on paving contracts. The responses were not as numerous as we had hoped for, but in all 47 replies were received, and the Secretary has asked me to tabulate them for presentation to the Society.

A summary shows that in 44 different replies:

13 municipalities retain 10% on current estimates;
17 municipalities retain 15% on current estimates;
13 municipalities retain 20% on current estimates;
1 municipality retains 25% on current estimates;

On final estimates

4 municipalities have no fixed rule; and 18 retain nothing.

The others vary so greatly both in amount and time of retention that a brief summary is impossible, the amounts running from 3 to 20 percent and the time from 30 days to 2 years. All the information received is shown on the table appended.

In view of the wide variation, would it not be well for the Society to recommend a standard which could be followed by all Cities?

Retained Percentages on Estimates

City	State	On Current Estimates %	On Final Estimates				Remarks
			Sewers		Pavements		
			%	Time	%	Time	
Montgomery...	Ala.	15			15	1 mo.	
Los Angeles....	Cal.	25	0		0		
Hartford.......	Conn.	10 sewers 15 paving	5	6 mo.			
Lakeland.......	Fla.	10	0		0		
St. Petersburg..	Fla.	0–25	5	1 yr.	0		
Chicago........	Ill.	15	0		0		
Salina.........	Kan.	15	0		0		
Topeka........	Kan.	10	3	1 yr.			Bond
Wichita........	Kan.	15		No fixed rule	2	2 yrs.	
Baltimore......	Md.	20	5	9 mos.			
Boston.........	Mass.	15	0		0		Maintenance Bond
Brookline......	Mass.	15	0		0		
Norwood.......	Mass.	15	0		0		
Minneapolis....	Minn.	10	0		0		Maintenance Bond
St. Paul........	Minn.	15	1–4	6–12 mos.	1–4	1 yr.	
St. Louis.......	Mo.	15	5	not stated			
Atlantic City...	N. J.	15	0		0		
Bloomfield.....	N. J.	20	10	1 yr.	10	1 yr.	
Hillside........	N. J.	20	10	1 yr.			
Mercer Co.....	N. J.	10	0				
Newark........	N. J.	20	5 3	1 yr. 2 yrs.	5 3	3 yrs. 5 yrs.	Except on granite.
Plainfield.......	N. J.	20	10	9 mos.	*		*5 year bond
Binghamton....	N. Y	15	5	1 yr.	5	5 yrs.	
Buffalo........	N. Y.	20	10	6 mos.	0		
Elmira.........	N. Y.	20	10	1 yr.	0		
New Rochelle...	N. Y	20	10	6 mos.	10	6 mos.	
New York.....	N. Y.	10–15			10	1–5	Payable in installments
Syracuse.......	N. Y.	15	varies	6 mos.	5	6 mos.	
Yonkers........	N. Y.	15	10	6 mos.	10	6 mos.	And bond
Cleveland......	O.	10	0		*	3–5 yrs.	*2–3c pr. sq. yd.
Columbus......	O.	10	10	2 yrs.	10	5 yrs.	
Lakewood......	O.	10	5	6 mos.	5	3–5 yrs.	
Loran..... ...	O.	10	10	6 mos.	*		*5 year bonds
Toledo.........	O.	10	5	1 yr.	5 3	1 yr. 2 yrs.	
Allentown......	Pa.	10	5	6 mos.	5	6 mos.	
Oil City........	Pa.	20	0		0		
Pawtucket......	R. I.	15	0		0		
Charleston.....	S. C.	20	20	1 mo.	20	1 mo.	
Dallas.........	Tex.	15	0		0		
Houston.......	Tex.	20	*		**		*1 year bond **5 year bond
Salt Lake City..	Utah	10–15	0		*		*1 year bond
Danville...	Va.	15			*		*5 year bond; sewers built by city
Norfolk........	Va.	15	7½	1 year			
Beckley........	W. Va.	10	0		0		
Beloit..........	Wis.	20	0		*	5 yrs.	*10c per sq. yd.
Ottawa........	Can.	10	10	1 year	10	1 yr.	
Winnipeg	Can.	20	*	1 year	0		*Percentage varies

THE PARKS OF BALTIMORE

By J. Cookson Boyd, President of Board of Park Commissioners, Baltimore, Md.

I have no paper to read. In fact, in addressing this assemblage of professional men I have a feeling of diffidence. My vocation is more in line with the law, than the building of roads or even of comfort stations. As the President of the Board of Park Commissioners of this city, however, it seemed that it would be only fitting that I say something to you about our parks.

I suppose I will be pardoned if even in our "own home town" I say that we not only have parks but we have the most beautiful parks in this country or in any country that any of you have ever traveled in. We have an extensive park system here when you consider it per capita. We know the parks of Minneapolis, and if this Convention should decide to go there next year I am sure that one of the pleasures of that trip will be a visit to the splendid parks of Minneapolis, with their beautiful lakes.

We were not always so fortunate as we are now. About 1858 there was a resolution of the city council of Baltimore providing for a parking system to consist of a boulevard around the boundary of the city with parking in the center and a driveway on either side. The boulevard as such was never established, altho we have many similar ones in the city at this time. In 1859 it was proposed to establish a real park and about 500 acres of ground, known as the Rogers Estate, which had been in that family for one hundred years before the Revolutionary War, were purchased for $1,000 an acre. The city had 150,000 inhabitants and decided to issue $500,000 worth of bonds bearing 6% interest. The deal came near being held up, because the owner of the land was unwilling to take his pay in 6% municipal bonds, which later rose to about 135. It was only after five liberal gentlemen each purchased $10,000 worth of bonds that he was satisfied. That park today could not be purchased for $50,000,000. In this connection, I want to say to you who are interested in municipal improvements, buy when you can buy at a reasonable figure, and don't wait until the time comes when a prohibitive price makes it impossible to have a park.

So we established our Druid Hill Park, now having nearly 775 acres, the most beautiful of the system of parks in Baltimore; with its rolling hills, dales and streams, its timber, hundreds of years old, and added to them the things that man can do.

The next acquired was Patterson Park. Parks should not only be selected because of their location, and the uses that can be made of them, but if possible because of the historic value and interest surrounding them. So we bought Patterson Park, the site of the old bulwarks thrown up in the War of 1812-1814. The decisive battle of our second fight for independence of this country was fought then, when Ross met his death, when the British had gone up the Potomac to Washington and burned down the Capitol, and come back intending to do the same thing to Baltimore; but they were beaten, and the second war was won. That not only is a historic spot, but it was named after historic people, because Patterson Park was owned by the father of Betsy Patterson, who became the Queen of Napoleon, the King of Westphalia.

The next park of any magnitude acquired was what is known as Clifton Park, which was the home place of Johns Hopkins. He died, leaving millions of dollars for the establishment of a University and a Hospital, the greatest University of Original Research, and the greatest hospital in the world.

Then we acquired Carroll Park, where you can see the ideal Colonial Mansion, where Colonial Exhibits are maintained by the Colonial Dames for the education of the people, a mansion built by Charles Carroll, the barrister, which Washington invariably made his stopping place on his trips from Washington to Philadelphia and New York. Then we have smaller parks and squares, Riverside Park, Federal Hill Park, the latter now renowned because in the old days of 1861, when we here in Maryland were half between the North and South, and it was impossible to determine which way Maryland was to go, the citizens of Baltimore woke up one morning and found encamped over on this hill, overlooking the river, a detachment under Ben Butler, and Maryland to its great advantage and now to its great credit remained in the Union.

We have another park, not under our jurisdiction just at the present time. During the war it was taken away from us for temporary purposes and used as a hospital. It does not belong to Baltimore alone. It belongs to the world. We are merely the custodians of it. That park with the Patapsco river running on either side, where on the 12th of September, in 1814, when guns from the battleships of Britain were assailing us, their fire was returned by the guns on this park; the place known as the birthplace of our National Anthem, written by Francis Scott Key; Fort McHenry Park. We ask your help at this time with the Government at Washington, to prevent the possibility of its sale, and secure its maintenance as a national park, in order that the birthplace of the anthem should be for all time held in esteem and reverence by the people of these United States.

We have other parks, the Gwynns Falls Park, along the banks of Gwynns Falls, and up between what seem to be almost mountains, on the crest of which you can look down on the

Bay from Gilston Heights, see its splendid timber, and the beautiful roads that have been built.

Nothing so advertises or adds to the value of a city, as parks; there is nothing that so builds up its health, that makes manhood. The parks are the lungs of a municipality. In the modern park you can't see a sign "Keep off the grass," except perhaps a muslin one which says "Seeded—Don't walk on it just yet."

Thus the parks are our playgrounds; the athletic features in our parks, forming a very vital part of the life of the community. Today the Board of Park Commissioners have largely taken over the financing of children's playgrounds. Just as we have taken the little child on the playground, so have we taken the larger child, the boy and the girl. And the result is that we have a youth in this community which is broadening its muscle, and its height, and ability to do things. We believe that the instruction to the young man as well as to the child should include not only the mental, but the physical. So we are trying to help out the school authorities in the education of our people by enabling our school children to be in a position to receive education in the best and most advanced condition.

We don't stop at the children but we go to the grown people. We have taken over the control of the public park baths, and we have a bathing pool over in Clifton Park which is a larger outdoor bathing pool than can be found anywhere in the country. This past year we had in the months of June to the early part of September, more than 250,000 people taking advantage of the opportunity of bathing there. We have similar bathing places in Patterson Park, and out near Carroll Park, at Gwynns Falls pool; and only this last summer we opened what we think is unique in the annals of the country, a bathing pool for the colored people of this city that will rival in magnificance and completeness any bathing pool that can be found anywhere in the United States. We believe we are not only doing a good thing for the colored man, but the white man, when we established that pool there and the results have justified it. You have spoken of comfort stations costing $40,000. Our bathing pools are costing more than $100,000 to build and more than $30,000 a year to maintain.

We have established in Clifton Park, a golf course.

It does not cost a single cent to play golf, or to take a bath, or do anything else in our parks unless you come without your bathing suit, and then if you are a boy six years of age or under it costs you one cent for the suit, which includes two towels and a piece of soap, and up to 12 years of age it costs you three cents, and above 12 to 15 it costs you 5 cents for your bathing suit, your two towels and your piece of soap. So you can see that Baltimore is not running its bathing facilities for any commercial purpose. The success of this has been so great that there is a crying demand for more.

As his Honor the Mayor told you in the opening address, within the past three years Baltimore has increased in its territory to three times its former area, and promises have been made to people in this annex that they are to get the same benefits as enjoyed in the old city, so that we will have a park in the Western section and one in the Northern section. We have already kept our word with reference to one in the Southern section.

You know Baltimore is a seaport, next to New York the largest on the Atlantic Coast. We have a great deal of boating here. And we believe that that spirit should be encouraged and therefore we are very much in favor of yachting. Since the incumbency of the present Mayor there has been established on the banks of the Patapsco River a riverside park named in honor of the Mayor, Breuning Park, and we expect to erect there one of the finest boat clubhouses to be found anywhere in the United States, large enough to house the various boat clubs of this city, giving them reasonable facilities for the storage of their boats, as well as facilities for social purposes that accompany affairs of that kind.

Back in 1860, before the time of street cars even, certainly when electric cars were never dreamed of, an application was made by some men who had formed a company that wanted to organize a street-car line and lay its tracks on the streets of Baltimore. Then the most valuable franchise that is known in this town was provided for, while since, many, many valuable franchises have been given away free of cost. The cost of the franchise of this street railway was an agreement that they should pay to the city of Baltimore for the maintenance of its parks 20% of their gross receipts, and they gladly accepted the condition, and in 1860, when the park was dedicated, the Mayor of the town then said that the year in which this franchise tax had been in effect had shown such good results that he anticipated at some time in the future there would be as much as $50,000 to $75,000 a year from that tax. For the year 1921 there has been collected on account of that tax a sum somewhat in excess of $1,100,000, and every cent of that has gone to the establishment and maintenance of the parks we have as well as providing for new parks.

We believe that the parking system should not confine itself to this certain territory. We believe that we should help wherever we can to make a city beautiful and so last year when municipal authorities all over the country, and especially in the city, were wondering how they could keep the tax rate down, it was suggested to our Board of Estimates that one of the departments it had been paying for out of its tax rate could properly be made a part of the park system, and we suggested if they would turn over to us the City Forestry Division, and take it from the Highways Engineers Department, we would be very glad to take it and pay for it. That was done and as the result we have saved the city of Baltimore in its Forestry Division alone nearly $40,000, and the City Forester told me only yesterday morning that, not only had there been a saving of money, but because of the fact that the Department was where it belonged, it had done twice as much work for the same amount of money this last year as it had been doing in years previous.

We look upon that tax as inviolate. It was reduced, it is true, from 20% to 12% many years ago, and it was reduced from 12% to 9%, the amount of it now. And, tho the company might not say so publicly, way down in their hearts they must admit that 9% they are paying, which yields to us $1,100,000 a year, is only a very fair charge for this most valuable franchise.

REPORT OF COMMITTEE ON CITY PLANNING

Harland Bartholomew, General Chairman, St. Louis, Mo.

The past year has been exceptional in the volume and wide range of activity in the city-planning field. Without having made an attempt to canvass the character and extent of work undertaken in various cities, some general observations with respect to current tendencies are herewith presented and some conclusions ventured.

State and Municipal Legislation

There has been a strong movement toward the passage of city-planning legislation in all parts of the country during the past year. The majority of this legislation took the form of passage of legislative enactments authorizing cities to appoint city-plan commissions and to undertake zoning work. State acts authorizing the creation of city-plan commissions were passed in Kansas, Tennessee, Illinois and Indiana. State acts authorizing the undertaking of zoning work were passed in Kansas, Missouri, Tennessee, Illinois, Indiana, and Michigan. In some of these states the act authorizing the city-plan commission gave power to control land subdivision, while in certain other states specific acts authorizing the regulation of land subdivision were passed.

In several states constitutional conventions are in session or under consideration and the opportunities offered for securing fundamental powers, such as excess condemnation, fixing streets on the city plan, creation of metropolitan districts for city-planning purposes, etc., were considered, notably in Illinois and in Pennsylvania.

In some cities the drafting of a new city charter likewise offered opportunities for the creation of city-plan commissions with certain power and authority. While possibly not coming strictly within the past calendar year, the charter provisions regarding city planning enacted in Minneapolis and in Detroit are interesting examples of what other cities might profitably do in this regard.

Zoning

Zoning has been the most active part of city-planning during the past year. Unfortunately there has been a tendency in many cities to undertake zoning without sufficient regard to the other phases of the city-plan. Zoning should never be undertaken as a first step in city-planning but rather should follow plans for the street system, for transit, for transportation and for public recreation. There has been a most favorable tendency in zoning work away from what might be termed "piecemeal" practice, or the establishment of restrictions by a municipality for particular neighborhoods, which falls within the zone of class legislation and is not considered legitimate or satisfactory procedure.

One of the most gratifying features of zoning work during the past year has been the advancement in the science, such as a marked tendency toward simplification of zoning ordinances, the use in some cases of a single map for all district designations, establishment of building lines (often by separate ordinance procedure) and further consideration and study of density of population regulations. Comprehensive zoning ordinances have been enacted during the past year in both large and small cities, including East Orange, N. J., Evanston, Ill., Gloversville, N. Y., Milwaukee, Wis., Montclair, N. J. and West Orange, N. J. Cities which are now undertaking the preparation of zoning ordinances range from the largest to the smallest cities thruout the entire area of the country. A list of these cities follows:

Atlanta, Ga.
Baltimore, Md.
Bogota, N. J.
Bound Brook, N. J.
Buffalo, N. Y.
Chicago, Ill.
Cincinnati, O.
Cleveland, O.
Cranford, N. J.
Dallas, Tex.
Detroit, Mich.
Elizabeth, N. J.
Gary, Ind.
Grand Rapids, Mich.
Hamilton, O.
Hoboken, N. J.
Hutchinson, Kan.
Irvington, N. J.
Jackson, Mich.
Kansas City, Mo.
Kansas City, Kans.
Lakewood, O.
Lansing, Mich.
Madison, Wis.
Memphis, Tenn.
Minneapolis, Minn.
Mansfield, O.
Orange, N. J.
Passaic, N. J.
Paterson, N. J.
Philadelphia, Pa.
Phoenix, Ariz.
Pittsburg, Pa.
Portland, Ore.
Rock Island, Ill.
Roselle, N. J.
Roselle Park, N. J.
Rutherford, N. J.
St. Paul, Minn.
So. Orange, N. J.
Springfield, Mass.
Toledo, O.
Tarrytown, N. J.
Troy, N. Y.
Wichita, Kan.
Wilmette, Ill.
Winnetka, Ill.

Street Planning

A very considerable amount of progress in street planning has been made during the past year. Several cities, including Portland, Ore., Memphis and Pittsburg have prepared major street plans. In other cities progress has been made on the execution of major street plans as well as on isolated street projects. Chicago still furnishes the leading example to other cities of the country in street improvement work, its various undertakings being too numerous for mention but which are described in detail in the 11th Annual Report of the Chicago Plan Commission recently published. In Portland, Ore., the publishing of the major street plan served as an incentive to the dedication of several miles of major streets that otherwise would have had to be opened by the usual cumbersome processes of condemnation. In St. Louis the Washington Avenue project was brought to completion and opened to traffic during the past year, and ordinances have been passed for a very considerable number of projects making a total of somewhat over 60 different street openings and widenings now actually under way, in connection with the execution of the major street plan.

In Detroit some progress was made in the development of the major street plan thru the passage of an ordinance providing for the Dix-High-Waterloo cross-town thorofare, which will provide a most important by-pass for traffic wishing to avoid the business district. Other gratifying progress was made in Detroit in connection with dedications and opening of major streets in the outlying sections of the city. Unfortunately the method of procedure under Michigan law whereby the necessity of improvement as well as the damages involved in street openings are determined by jury, resulted in the abandonment of the Randolph Street project and the Grand River widening plan, two particularly desirable, tho expensive, projects in the business section of Detroit.

An exceptional amount of progress has been made in Pittsburg in connection with street planning. The widening of Second Avenue from 40 ft. to 80 ft. thru the business district, as well as the widening of Ferry Street in the business district, were completed and opened to traffic and are already affording a very considerable amount of relief to vehicular congestion, advancement in property values and general satisfaction. Pittsburg, likewise, has brought to completion several other street-widening projects provided for under the $10,000,000 bond issue authorized in July, 1919, for this character of work. The street problems of Pittsburg are intensely difficult owing to extremely difficult topography. The Citizens Committee on the City Plan of Pittsburg has just published a most elaborate major street plan study after two years of careful consideration. This plan is particularly interesting in view of its consideration of the problem of grades—a three-dimensions study in city-planning.

In Boston, legislative action during the past year has made possible the final undertaking of the Stuart Street-Elliot Street project, a most important undertaking that will have an extremely large effect on traffic movement as well as upon the future expansion of the business district of Boston.

Railroad, Waterfront and Terminal Improvements

The past year has witnessed two remarkable advancements in terminal and water-front planning. The report of the New York-New Jersey Port and Harbor Commission marks a mile-stone in port planning, which assumes regional proportions and is the latest and most remarkable of a considerable series of studies of this character published during the past year. The recent signing of the Port Treaty between the authorities of New York and New Jersey insures very great advancement in the planning of the leading port of America.

In Chicago, railroad authorities and city officials came to an agreement with respect to railroad terminals and lake front improvements, insuring a new Illinois Central Terminal on the line of Roosevelt Road; the electrification of all railroads entering this terminal and the reclaiming of the lake front from Grant Park to Jackson Park for recreation purposes, in accordance with the Chicago Plan. This improvement marks the largest accomplishment yet recorded in this character of work and is of too great magnitude for further description in this brief paper.

Conclusion

It is estimated that between 200 and 300 cities now have city-plan commissions or are actively undertaking city-planning work. As one looks back over the past decade it is indeed gratifying to see the remarkable advancement that has been made in city-planning work, and the almost general reversal of the former opinions that city planning had to do primarily with aesthetic matters. Today it is generally understood that city planning is a matter of economy and of such social necessity that the city which wishes to compare favorably with others in opportunities for industrial development, commercial enterprise or agreeable home conditions, cannot longer rely on the haphazard policy of municipal growth.

It is most generally to be observed that the cities accomplishing most in city-planning work are those which have definite and comprehensive city-plans already prepared. For those cities which wish for accomplishments, this conclusion cannot be overemphasized.

The first consideration should be to get a comprehensive city plan. The second consideration should be that that plan be prepared in a most logical manner rather than to undertake or over-emphasize one particular element, such as zoning or public recreation, and in so doing try to create the impression that the city has a city-plan. In connection with the development of a comprehensive plan, it is suggested that studies be made in the following order:

1. Major street plan
2. Transit plan (street car lines)
3. Transportation plan (steam and electric railroad location and terminals)
4. Public recreation plan
5. Zoning plan
6. Civic art.

Once these studies have been made it should not be assumed that the plan will be followed or that the work of the city-plan commission is complete, rather this work has just begun. Every city of 50,000 and upwards can afford sufficient appropriations to maintain a city-planning office with at least one well trained employe. Once the comprehensive city-plan has been prepared, there will be much work of an educational nature and considerable work of a technical character in connection with the execution of various projects involved in the city-plan.

The foregoing somewhat rambling statements are presented with the hope that members of the American Society for Municipal Improvements, being essentially city engineers and public officials having charge of the execution of public work, may realize the intimate interrelationship between city-planning and so many public improvement projects pertaining more especially to streets, transit and transportation problem. Cities have reached the stage where responsible public officials cannot longer afford to cast aside the principles of city-planning as something aesthetic, and hence beneath their notice; rather city-planning has now reached the point where it will more and more dominate the general principles of design and location of future public work. In this we may take satisfaction in knowing that there will be less wastefulness, more orderly and hence more attractive cities.

REPORT OF COMMITTEE ON CITY PLANNING, SUB-COMMITTEE A—LOCAL SUBDIVISIONS

Nelson P. Lewis, Chairman, Brooklyn, N. Y.

Your Sub-committee A, of the Committee on City Planning, submits the following report upon Local Subdivisions.

It is scarcely necessary for the committee to enlarge upon the importance of the control of local subdivisions, in the interest of the development of a proper city plan or to insure respect for such plan when made. The committee is not presenting a paper, or a thesis, upon this subject, believing that a simple statement of existing practice and the degree of control exercised by a number of typical cities will be of more value to the members of the Society than would an expression of the views of the committee or its individual members. The problem can be simply stated and the essential facts can be brought out by very few questions, the answers showing good control, partial control, or little or no control by the municipal authorities. The committee did not deem it necessary to compile statistics from a great number of cities, but seven questions were sent to representatives of 35 cities, the officer addressed being, where possible, a member of this Society. Twenty-five replies have been received, these including cities in different parts of the country, varying in population from about 100,000 upwards.

Fifteen report that they have very good control over subdivisions within the city limits.
Three of them appear to have partial control.
Seven have little or no control.
Ten of the cities reporting have a large measure of control over the filing of plans relating to territory for certain distances outside of the city limits, in one case 15 miles, while the other 17 have no control whatever beyond the red line indicating the city's corporate limits.

Cities Having Various Degrees of Control over Subdivision Platting Within City Limits

Good Control	*Partial Control*	*Little or No Control*
Chicago	Baltimore	Bridgeport
Cincinnati	Birmingham	Hartford
Cleveland	Buffalo	Milwaukee
Detroit	Kansas City, Mo.	Paterson
Indianapolis	Louisville, Ky.	Providence
Los Angeles	(5)	Springfield (Mass.)
Minneapolis		Yonkers
Newark		(7)
New York		
Norfolk		

Philadelphia
Pittsburg
Rochester
St. Louis
Washington
(15)

Cities Having or not Having Control over Subdivisions Outside City Limits

Control for Various Distances

Chicago
Cincinnati
Cleveland
Detroit
Indianapolis
Los Angeles
Minneapolis
Norfolk
Rochester
Washington
(10)

No Control

Baltimore
Birmingham
Bridgeport
Buffalo
Hartford
Kansas City, Mo.
Louisville
Milwaukee
Newark
New York
Paterson
Philadelphia
Pittsburg
Providence
Springfield
St. Louis
Yonkers
(17)

Cities from Which No Reply to the Questionnaire was Received

Boston
Dallas
Des Moines
Little Rock
Memphis
New Orleans
Portland, Ore.
San Francisco

Without further introductory statement the committee presents the seven questions submitted by it, and a brief abstract covering the situation in 25 cities as brought out by replies to its questionnaire.

Questions Submitted

1. What method has your city of controlling the local subdivision of property so that it will conform with a plan already adopted or will be a suitable plan for the territory included, both with respect to the topography and the existing plan of contiguous or nearby territory?

2. Is any regulation of this kind included in general state law, in the city charter, or in the city ordinances or regulations which can be changed by the local authority?

3. What city authority is charged with the enforcement of such law, ordinance or regulation?

4. Are real estate developers disposed to conform with such law or regulation and are they inclined to consult the authority charged with its enforcement and secure advice before presenting or filing their plans?

5. Are developers free to file in offices of record plans for subdivisions which have not been approved by the municipal authorities and sell by reference to such plans?

6. Has your city any means of controlling the subdivision of property outside but contiguous to the city limits?

7. What do you suggest as the best and most effective method of controlling local subdivisions?

Abstract of Answers to Questionnaire Relating to Control of Property Subdivisions

Bridgeport, Conn. The city appears to have no control over subdivisions of property which would insure their being consistent with city plan already adopted or that they should be reasonably adapted to the topography, or to the plan of contiguous and nearby territory, except that the Town Clerk may refuse to accept maps for filing unless the streets are accepted by the city; the authority authorized to accept plans for new streets being the mayor and the board of aldermen. It appears, therefore, that acceptance is an act performed by the mayor and the legislative body, rather than by an officer or a commission, whose special function it is to see that all such plans are consistent with the comprehensive plans which are being made and have already been adopted by the city of Bridgeport.

It is further stated that developers are free to file in offices of record plans of subdivision without approval by the municipal authorities, and that they can sell lots by reference to such plans, and that there is no means of controlling the subdivision of property beyond the city limits.

The reply to the questionnaire states in conclusion that the method used in Washington, D. C. or some modification of that method would be effective in controlling local subdivision.

Buffalo, N. Y. Plans showing new streets and lot subdivisions must first be presented to the city engineer and the commissioner of the department of public works for their approval and, after such approval, to the city council which by majority vote may accept the streets shown thereon as public streets. The council may also prescribe conditions for the acceptance of any street, including title or easement and improvements already made. No map subdividing lots upon a new or proposed street or purporting to show a dedication shall be filed in the office of the county clerk or incorporated in the maps of the assessor unless there is attached a certificate from the city clerk indicating that the street has been accepted. The chief intent of these regulations appears to be the control of dedications, but it incidentally serves to give the municipal authorities control over the platting of new streets.

The city engineer advises that Buffalo has not increased its area by annexation since 1854 and consequently most of the territory within the city limits has already been subdivided and changes or improvements in the plans involve the widening of existing or the acquisition of new streets. Attention is further called to the fact that with five cities and incorporated villages along the Niagara Frontier within 30 miles, the great need of this district appears to be a regional plan which should be worked out by cooperation between the different political units. To give the city of Buffalo control of the planning of the entire region would probably result in friction.

Chicago, Ill. A general law, known as Chapter 24 of the Revised Statutes of Illinois, passed in 1917, provides that any city council or the board of trustees of any village, is empowered to provide by ordinance that any map, plat or subdivision shall be submitted to the council or trustees, or to some officer to be designated, for their or his approval; and in such cases no such map, plat or subdivision shall be entitled to record in the proper county, or have any validity until it shall have been so approved. In Chicago the authority thus vested in the city council has been delegated to the superintendent of maps, this action of the council having been expressed in the following statement of the duties of the superintendent,—

> He shall be ex officio examiner of subdivisions, and it shall be his duty to examine any map, plat or subdivision of any block, lot, sub-lot or part thereof, or of any piece or parcel of land, situated within the city of Chicago, presented or submitted to him for approval, and if he approve of the same, he shall so certify.

These provisions appear to have resulted in the pretty general adoption of a rectangular street system, with streets having a minimum width of 66 ft., in the matching up of streets at subdivision borders, and to have prevented the closing of old diagonal turnpikes, but no attempt has been made by the superintendent of maps to enforce the details of the "Chicago Plan," which has never been legally upheld by the decisions of the superintendent of maps. A statute, which became a law on June 24, 1921, provides that any city, village or incorporated town may provide for the creation of a plan commission, one of the powers of which is to prescribe reasonable requirements in reference to streets and public grounds in unsubdivided lands within the corporate limits and in contiguous territory outside of and distant not more than one and one-half miles from such limits, which is not included in any city, village or incorporated town. Real estate developers have in very few instances opposed action taken under this law, and most of them consult the superintendent of maps and act upon his advice before submitting plats for approval.

It is made unlawful for any recorder to accept and record maps for the subdivision of land in any incorporated city, town or village, until they shall have been approved by the legislative authority of the town or by some officer designated by resolution or ordinance by such legislative authority, and for every violation of this provision by any recorder or his deputy, a penalty of $200.00 is imposed.

The statement is made that the system now in operation works fairly well but principally because they have a good man as superintendent of maps and the prediction is made that it will work still better when the plan commission takes advantage of the new law and insists that the major streets shall be developed as they should be in new subdivisions, it being pointed out that the new act gives the plan commission jurisdiction only over major and not over minor streets, and the suggestion is made that the city council, under authority of the cities and villages act, pass an ordinance establishing standards for subdivisions which will apply to the minor streets.

Cleveland, Ohio. Cleveland appears to have quite effective control over the subdivision of property by real estate developers. All plats of subdivisions must receive the approval of the director of public service, who is designated as the platting commissioner by state law, before they can be accepted for record in the county recorder's office. Real estate developers are reported to be disposed to consult the city authorities when planning their subdivisions, and the Cleveland real estate board cooperates with the municipal authorities in the framing of regulations governing this subject. The state law provides that cities may control the layout of streets for a distance of three miles beyond the city limits. The city charter contains explicit provisions regarding the platting of land, indicating just what shall be shown upon the maps, fixing a minimum width of 40 ft. for streets and 20 ft. for alleys, and providing that, where possible, no blocks shall be longer than 1000 ft. It is said that this method of control is very satisfactory with the possible exception that land might be sold under a metes-and-bounds description without having previously obtained approval of the plan of the street upon which the lots abut, but there has been little difficulty within the city limits from this source, as developers find it to their advantage to cooperate with the city authorities.

Hartford Conn. Control over property subdivisions is exercised by the city-planning commission which consists of the mayor, the president of the board of street commissioners, the president of the board of park commissioners, the superintendent of parks, the city engineer, two members of the board of aldermen and two citizens not holding any public office. This Commission is provided for in the city charter in which there appears to be no special provision governing the acceptance of plats for property subdivisions, altho the charter provides that the board of aldermen shall refer all questions concerning the location of boulevards, parkways, streets and parks to the city-planning commission for consideration and report, before final action is taken.

It is stated that real-estate developers, before submitting their subdivision plans, generally confer with the city engineer, who is secretary of the commission, and that the city clerk will not accept plans submitted by property owners until the same shall have been approved.

There is no control by the city-planning commission, or other municipal authority, over the filing of plans for property outside the city limits.

Indianapolis, Ind. A state law requires that plats of all subdivisions within the city limits, or within 4 miles beyond the same, shall be submitted to and approved by the city-planning commission, and that no property can be sold by reference to such plats until they shall have been approved by the commission and then filed in an office of record. This requirement does not appear to be the subject of any city ordinance or charter provision but is included in a state law providing for the establishment of the city-planning commission and outlining its powers, which appear to be extensive enough to enforce its judgment.

While the statement with respect to Indianapolis is very brief it indicates that the city has a very satisfactory degree of control over property subdivisions and such control extends four miles beyond the city limits.

Los Angeles, Cal. Los Angeles has a city-planning commission and all subdivision plats covering property within the city limits must be passed upon by that commission before they can be filed in offices of record. This provision appears in the law enacted in 1915, under which the city-planning commission operates. It also gives to the commission the right to review subdivisions outside the limits of the city and within three miles thereof. None of the provisions above referred to are contained in any ordinances or even in the city charter but are in statutes enacted by the state legislature. In view of these provisions the control of subdivisions is stated to be almost automatic inasmuch as sales by reference to property maps are forbidden unless these maps are on record and they cannot be placed on record until they shall have been approved by the city-planning commission. It is reported that one additional power is very desirable, and that is control of the size of parcels of land that may be sold, but it is hoped that this may be worked out thru the means of a zoning plan.

The city-planning commission is a relatively new department of the city government and there has hardly been time to establish an intimate relation between it and realty developers, but it is stated that within the year during which the commission has been active there is evident an increasing tendency on the part of subdividers to confer on their tentative plans. In order to encourage this a pamphlet is now being prepared for circulation that will advise real estate developers of the requirements of the commission and the machinery involved in having their plans approved and placed on record. While there is at present a limited control over the platting of property within three miles of the city limits an effort is being made to bring about a more extensive control thru cooperation between authorities of the county and the various towns in the Greater Los Angeles District thru the medium of a regional planning conference, now being organized.

It is stated that the practice which has been established works very well. Each subdivision plan is referred, first to the city engineer in order that it may be checked with his records, and the commission then considers the plan in its relation to the major street system of the city and county, the park and boulevard system and the zoning system. Recommendations of the committee go to the city council for its concurrence.

Louisville, Ky. The city charter provides that any owner desiring to lay out or offer for dedication any street within the city limits shall file with the board of public works a topographical map of the territory and if that board thinks the proposed dedication would be beneficial to the public interest and suitable for immediate or future acceptance by the city, the board shall approve said map and shall affix its certificate of approval, when the map may be received for record in the office of the clerk of the county court. The charter further provides that any proposed dedication within three miles of the city limits shall be submitted to the board of public works and the county judge for approval. If the board refuses to approve the proposed dedication for 30 days, the property owner may have the right of appeal to the circuit court. It appears that what is intended to be especially controlled by these charter provisions is the dedication of property rather than the plan of the subdivision in order to insure that it is consistent with that of the remainder of the city, altho the board of public works can, if it chooses, take all of these facts into consideration, but no special emphasis is laid upon the nature of the plan itself. It is stated that the board of public works "meets with hearty cooperation from the majority of real estate men and private owners."

The charter further provides that no person may lodge for record in the county clerk's office, nor may any county clerk or deputy receive for record, any map or deed contrary to the provisions of this act, and a penalty of not less than $25.00 or more than $100.00 is prescribed for each offense. The city engineer advises that there are cases where such plats have been filed in the past without approval by the board of public works and lots have been sold by reference to such plats and he does not know whether the provisions of the act have ever been tried out in court or whether the board would be sustained in a court proceeding.

Milwaukee, Wis. There seems to be little control exercised by the city of Milwaukee over property subdivisions. It is stated that plans for such subdivisions must be approved by the common council before being put on record, this being required by an ordinance adopted by the common council, itself, but no legislative body can have the facilities for critical examination of plans of this kind and is scarcely likely to make constructive suggestions for their amendment or improvement.

It is stated that no subdivision is legal until after it has been recorded in the office of the register of deeds, but apparently any plan approved by the common council will be recorded upon presentation.

Real estate developers are said to be disposed to conform with such regulations as there are; this is not surprising as they appear to be free to do very much as they please.

In response to an inquiry as to whether the city has any means of controlling the subdivision of property outside of but contiguous to the city limits, it is stated that approval by the board of supervisors is required in all such cases, as is approval by the common council for subdivisions within the city, and it is probable that the examination of such plots will be no more searching or critical than is the case when made by the common council.

The results are said to be generally satisfactory. In view of the slight degree of control by the municipal authorities it may be that Milwaukee is blessed with a particularly capable, far-sighted and unselfish group of real estate developers.

Minneapolis, Minn. Minneapolis has a city-planning commission and in the new city charter adopted in 1920 that Commission is not only authorized to acquire or prepare a comprehensive city plan for future development, to recommend specific plans for public improvements consistent with that plan, and to recommend to city council a zoning plan, but it is given control over plans for property subdivision. All such plans, plats or replats of land laid out in building lots and streets must be submitted to the city-planning commission for its approval, and it is unlawful to receive or record such plans in any public office unless they shall bear an endorsement indicating approval by the commission. The disapproval of the plans shall be construed as a refusal by the city of any proposed dedication shown upon them, while approval by the commission shall be deemed an acceptance by the city of the dedication, but shall not impose upon the city any duty concerning maintenance or improvement until appropriations shall have been made therefor. It is distinctly stated that the duties of the city-planning commission in accepting or rejecting a plat "shall be deemed legislative and discretionary and not administrative. Another section of the charter empowers the city council to pass ordinances authorizing the city-planning department to administer and enforce all ordinances and regulations relative to city planning.

There is similar control over subdivision plats covering land outside the city boundaries and within three miles thereof.

Newark, N. J. It is stated that tentative plans have already been prepared for such parts of the city as are likely to be developed in the near future and that 90% of the upland has already been developed.

All plans made by private developers must be submitted to the department of streets and public improvements for approval or disapproval. If approved, and bearing signatures to that effect, they may be filed in the office of the county register.

The city has no control over the platting of property outside its corporate limits, and in fact the territory immediately adjacent to Newark is nearly all developed or is included in some city or incorporated town, and the public authorities of these municipalities have generally been willing to cooperate with those of the city of Newark in working out their street plans.

The statement is made that the present law is adequate in giving the city such control as is necessary over what appears to be the very limited amount of private subdividing which can still be done, but that Newark's most difficult problem arises from the necessity of widening existing thorofares and the opening of new streets to relieve central traffic congestion. In view of the great population in this part of New Jersey, and the rapid growth of the surrounding communities, the city appears to need power to control even the small amount of private subdivision still possible in order to insure a street plan which will not result in a repetition of the present necessity for widening existing thorofares and opening new streets to relieve traffic congestion.

Legislation has been proposed authorizing the creation of county-planning commissions for counties of the first class and a draft of a bill designed to bring this about contains provisions that such county commission shall recommend to the respective governmental authorities, among other things, the planning and laying out for urban uses of private grounds embraced within the counties, and that all plats and replats of any land within the county shall first be submitted to the county-plan commission for its report and approval.

New York City. New York prior to 1916 had no control over the filing of plans of subdivisions whether the territory covered by them had been officially mapped or not. During the last five years, however, two statutes have served to give quite effective control. One is a portion of the general real-estate law forbidding the sale of lots purporting to front upon streets unless maps showing both streets and lots shall have been filed in an office of public record. The other forbids any office of public record from accepting and filing any such maps unless the same shall have been approved by the board of estimate and apportionment. In order to prevent unnecessary delay in action upon such plans this last act provides that failure of the said board to approve or disapprove within 21 days shall be equivalent to approval. It is provided that if there are no meetings of the board scheduled which will permit action within 21 days, the power of approval or disapproval may be, and in such cases always has been, delegated to the chief engineer of the board. It was at first necessary to disapprove quite a number of plans, until developers and their engineers found that it was better to consult the engineering staff of the board of estimate and apportionment before submitting their plans, this policy having been followed quite generally of late.

This explicit provision of law has been evaded in several instances in a rather ingenious way. It was found that two conveyances of real estate had been presented for record to the county clerk of one of the five counties within the city to which there had been attached and made a part thereof a reproduction on a small scale of a subdivision map showing by numbers the lot conveyed and a number of other lots. The map attached to each of the deeds covered a considerable area, the two lots conveyed being located in the diagonally opposite corners of the tract covered by the two plans. It was a nice question whether the county clerk could refuse to accept a deed, presented in apparent good faith by the purchaser, which depended for its description of the property conveyed upon a plan attached to the conveyance, an extra copy of which plan was provided for insertion in the liber in which the deed was to be copied. Probably the recording officer would be obliged to accept it and the penalty, if any, for violation of the intent of the statute might be recovered by the grantor.

New York has no control whatever over the subdivision of property outside of but contiguous to the city limits. Not only do some of the plans for the development of such contiguous areas fail to harmonize with those adopted by the city, but, altho the political consolidation creating the present city took place nearly 24 years ago, there can still be found instances of the same lack of coordination between what were then different political jurisdictions, now part of the greater city.

Norfolk, Va. The city of Norfolk, Va., appears to have secured legislation conferring upon it a very unusual degree of control over plans for property subdivisions and equally unusual authority to plan for territory outside the city limits. In the case of subdivision plats any person or corporation desiring to file such maps must file a copy with the city engineer or, if located in the county and outside of the city, with the board of supervisors or with the engineer of roads of the county, or if there be no engineer of roads with the county surveyor. If the city engineer, or the board of supervisors and the road engineer, or the county surveyor fail to agree or act within 30 days after filing of the application to them, the subdivider may, upon 10 days notice to the city, apply to the judge of the circuit court who, after hearing, shall enter an order approving or diapproving the plan, and if the order is for approval, the clerk shall record the plot. Even if the engineer or engineers in the first instance disapprove the plan, the applicant shall still be entitled to appeal to the court. The above provisions apply to any subdivisions within 15 miles of the limits of the city. A peculiar feature of this statute, enacted in 1918, is that it is made to apply to any city having a population of not less than 60,000 nor more than 110,000 inhabitants. At the time of its enactment Norfolk was the only city in the state with a population between these limits. According to the census of 1920, Norfolk is credited with a population of 115,777, while no other city outside of Norfolk and Richmond has reached the 60,000 mark. The question naturally suggests itself as to whether the law above quoted still applies to the city of Norfolk. Further inquiry has been addressed to the city clerk to determine this question but no reply had been received at the time this report was written.

It is stated that the director of public works, acting under authority conferred by this same statute, has prepared a map showing the outlying districts as far as Virginia Beach.

Paterson, N. J. The chairman of the city-plan commission, in response to the questions submitted, says that the answer must be "a general negative." It was stated that further investigation would be made in the hope of giving more specific answers but nothing further was received up to the time of writing the report. It is assumed, therefore, that the city has no control over subdivisions for real estate development either within or without the city limits.

Philadelphia, Pa. The Philadelphia board of surveyors, created by statute, is given power, *on authorization by the city council*, to prepare and adopt plans for all streets, including the location, width and grades, and from their action there is no appeal except to the court, and such appeal must be taken within 30 days after action by the board. This authority applies also to the revision of street lines and grades, as such revision may from time to time appear to be necessary. It does not appear that this extraordinary power of the board of surveyors specifically applies to the case of plans for property subdivision made by private owners, but the absolute control of this board over the final plan, it is held, deters such owners from the filing of plans which may not conform with the final street plan which has been or may be adopted, altho there appears to be no prohibition against the filing of plans without positive approval by the board. The risk of not having such plans approved and confirmed by the board of surveyors, disapproval by that board carrying with it refusal for permits for improvements, is so great that there is a disposition on the part of developers to consult the board, or its representatives, before the filing of plans.

As to the minimum width of streets and other details, there is no city ordinance but absolute power seems to be vested in the board of surveyors. There is no provision of law giving this board, or any other city authority, control over subdivisions lying outside the corporate limits of the city.

Pittsburg, Pa. A Pennsylvania statute, applying to cities of the second class, which includes only Pittsburg and Scranton, provides that there shall be a city-planning commission and that—

> all plans, plots or replots of lands laid out in building lots, and the streets and alleys and other portions of the same, intended to be dedicated to public use or for the use of purchasers or owners of lots fronting thereon or adjacent thereto, and located within the city limits, shall be submitted to the city-planning commission and approved by it before it shall be recorded. And it shall be unlawful to receive or record such plan in any public office unless the same shall bear thereon, by endorsement or otherwise, the approval of the city-planning commission.

In Pittsburg the power of regulation rests entirely with the department of city-planning which is the authority charged with the enforcement of any laws or regulations relating to property subdivision. Real-estate developers frequently submit tentative plans to the department for their consideration before their formal presentation. There is no control over subdivisions outside the corporate limits of the city, altho the city-planning commission is authorized to prepare and submit to councils maps including territory three miles outside thereof.

The submission of a plan for property subdivision and its approval by the city-planning department and acceptance by councils constitutes a complete dedication of the streets shown thereon.

The rules adopted by the department of city-planning provide for a preliminary plan showing approximately the property lines, buildings, topographical features, proposed location and width of streets, and minimum size of lots. Final or record plats must give the same information more precisely. Contour lines, with intervals of 10 ft. elevation, must show the present surface. No dead-end streets will be approved, except where conditions render an extension impracticable and then only when adequate turning spaces are provided at the inner ends. The minimum street width is 40 ft., 50 ft. suggested as a suitable width for residence streets, with minimum roadways of 20 ft. All subdividing must be done in a manner which will not debar the owner of adjacent property from access to the streets, and provision must be made for continuing existing streets in adjoining plots. The final or record plat shall not be signed by the owners and acknowledged until after the adoption and recording of an ordinance establishing the street grades and lines.

The form of dedication placed upon the final plan contains a sworn statement that the owner does "dedicate forever, for public use for highway purposes to the grades designated and shown . . . all the streets . . . shown on said plan with the same force and effect as if the same had been opened thru legal proceedings; and . . . release and forever discharge the city from any liability for damages arising from the appropriation of said ground for public highways and the physical grading thereof to said grades."

Providence, R. I. There appear to be neither city ordinances nor state laws governing the subdivision of property but every such subdivision must be approved—first, by the city engineer, then by the board of aldermen, but as there are no laws or ordinances there appears to be no city authority to which has been legally delegated any particular power, and what control there is seems to be that which is assumed by the city engineer and the board of aldermen and to some degree, at least, acquiesced in by the property owners. It is stated that "real estate developers sometimes, but not always, consult the city engineer regarding the development of their property and the best method of street lay-outs and street arrangements, together with drainage possibilities."

In answer to the question as to whether developers are free to file in offices of record plans for subdivisions which have not been approved by the municipal authorities, the question is answered in the negative, but no information has been given to indicate why they cannot do so.

No city official appears to have any authority extending beyond the corporate limits of the city. It is stated that laws would be very beneficial that would prohibit the platting of streets less than 60 ft. in width, and which would require approval of plats by the city engineer or the city-planning commission, and the need is also indicated of statutes prohibiting owners of land from making plats according to which they make sales, without putting such plats on file. In the Italian districts, for instance, streets have been shown on unaccepted plats with a width of 30 ft. and are so laid out that it is practically impossible to provide proper drainage.

Rochester, N. Y. Rochester appears to have, thru its bureau of city planning and the unusual powers given to that bureau, a better control of property subdivisions by private individuals or corporations than any other city from which information was secured.

The city charter provides, in the first place, for a superintendent of city planning, whose authority over the development of a city plan in all its aspects is unusually complete. Among other things it confers upon him power to accept streets offered for dedication, to pass upon all proposed plans for opening, widening, extending or discontinuing streets, or fixing the width of roadways and sidewalks, and no ordinances for any such purpose may be adopted without his recommendation or approval. It authorizes him to prepare a plan covering not only the territory within the city limits but within one mile of the city boundaries "and such further territory outside of the city as the superintendent may deem proper."

With respect to private subdivisions the charter provides that before any owner of any tract within the city can sell any portion in subdivisions he must prepare a plan which must be first approved by the superintendent of city planning and by the city-planning advisory board, and after such approval it must be filed in the office of the county clerk and a copy delivered to the assessors.

The superintendent of city planning has, under the powers given him, authority to formulate and promulgate rules and regulations in relation to the lay-out, acceptance and dedication of streets. Space does not permit a general outline of these rules but they are very explicit and result, as already stated, in giving the city of Rochester more complete control over this troublesome matter than appears to be enjoyed by any other city.

Springfield, Mass. There appear to be no regulations controlling the subdivision of property by real estate developers with the single exception that the city refuses to accept as public highways any streets platted with a width of less than 30 ft. It is said that there is no provision in state law or city charter which prevents the filing for record of subdivision plats unless the same shall have been approved by the municipal authorities. In response to a question as to whether real estate developers are disposed to conform with regulations or to consult the municipal authorities before filing their plans, the answer is "No," this at least implying that the developers do as they please with no reference to the official or unofficial policies of any city department or official.

In response to a request for a suggestion as to the most effective means of controlling local subdivisions, the answer is "The adoption by the city government of city plan to be prepared by the planning board together with a zoning ordinance and, pending such adoption, the acceptance by the city of the board of survey act, General Laws of Mass. 1920."

Springfield was perhaps the first city in the United States to adopt and carry out a plan for a civic center but it does not seem to have solved one of the most vexed problems of city planning by acquiring control over the subdivision of land by real estate developers.

Washington, D. C. While Washington had perhaps one of the best and most comprehensive plans of any American city, it does not cover the entire District of Columbia, and there appear to be considerable areas even within the limits of the cities of Washington and Georgetown which are bounded by streets laid out on the plan but which are susceptible of further subdivision. The commissioners of the District of Columbia have ample power to regulate such subdivisions. In 1888, and again in 1899, regulations were promulgated covering this and providing for the submission of plats which, when approved, are filed and recorded in the offices of the surveyor and the assessor of the District. The regulation of 1899 provided for subdivision into lots not less than 16 ft. wide and 50 ft. deep, with certain exceptions, but a regulation issued as late as August 23, 1921, modified this regulation to permit lots not less than 14 ft. wide, nor less than 50 ft. deep, provided each lot have at least 4 ft. in rear or side abutting on the existing public alley or street. This loosening of the requirements would appear to permit more intensive use of rear lots and those fronting on alleys than would be desirable in any city, much less in the national capitol.

An order, promulgated by the commissioners of the District on Jan. 30, 1907, added a new section governing dedications of streets in conformity with highway extension plans, this order providing that streets, with a proposed width of from 90 to 120 ft., might be dedicated at a width 30 ft. less than that established, provided the parties dedicating it agree to establish building restriction lines to agree with the street lines shown on the plan; that streets 130 ft. and 160 ft. wide may be dedicated to the width of 90 and 100 ft. respectively, subject to the same provisions, the space between the street lines and the building restriction lines to be considered as private property to be set aside for parking purposes and to be subject to the regulations of the commissioners in regard to height of parking and projection of buildings beyond the building line, the District also to have right-of-way thru these parking strips for sewers, water mains and sidewalks.

Yonkers, N. Y. The city appears to have no method of controlling plans for subdivisions made by developers. Yonkers has not taken advantage of the "Second-Class-Cities Law" of the State of New York, authorizing any city to appoint a city or village planning commission, for the reason, it is stated, that to do so would take away power from the common council, while the commission would be required practically to guarantee all titles of transfer. Real estate developers do not consult any city authority but they are required to file plans in the county register's office and the city clerk's office, tho it appears that such plans may be accepted for filing without any evidence that they have been approved by any responsible city officer. The city has no control over the platting of property in territory outside its corporate limits but contiguous thereto.

A zoning ordinance has recently been adopted and the city engineer, who is a member of this subcommittee, expresses the belief that this is the first step in some method of controlling subdivisions and that such control should be placed in the office of the city engineer and his approval be required for all street lay-outs both as to street grades, widths and location. As illustrating the present unsatisfactory situation the city engineer quotes from a typical letter from a surveyor stating that he is preparing plans for a subdivision and that the owners wish to make the streets 35 ft. in width with a paved roadway 18 ft. wide, expressing the belief that as the plots are to be large this street area would be sufficient, and he asks whether there is any ordinance fixing the minimum width streets. In reply to this question the surveyor was told that the city is not accepting streets less than 50 ft. wide but that there is no objection to providing a paved roadway of 18 ft. with sidewalks of a total width of about 35 ft. thus permitting the city to widen the roadways in the future, without incurring liability for damage.

Baltimore, Md. The situation in Baltimore is peculiar in that one municipal authority appears to control the street plan with respect to the portion of the city mapped prior to 1888 and another with respect to the remainder. Control over the city as it was prior to 1888 was vested in the city council. Additional territory was added in that year but a street plan for it was not adopted until ten years later. No street can be opened in this new territory that does not conform with the plan of 1898 and the plan can be amended only by joint action of the topographical survey commission, the mayor and the city council. There has been a recent addition of 60 sq. mi. to the city area and plans for that territory are now being made by the topographical survey commission. It appears that, while there is no statutory provision requiring approval by any municipal authority of plans for subdivisions before they can be filed in an office of record and sales made by reference to them, real estate developers are anxious to conform as closely as possible with the city's plan. Cooperation between developers and the commission means as much in carrying out the street plan as does the statute.

The city has no control whatever over subdivisions outside the city limits. The question of more effective control is now under study and the chief topographical engineer advises that the commission feels that it is working in the right direction by securing first a complete and accurate topographical map covering the area of the plan.

Cincinnati, Ohio. Quite effective control over subdivisions is given by the state law referred to under Cleveland, this providing that no plan of plats for such subdivisions, where property within a municipality is involved, may be recorded in the office of the county recorder without written approval of the platting commissioner of the city; in Cincinnati the city planning commission is designated as the platting commission. This commission, by the adoption of rules governing the preparation and submission of subdivison plans, is thus able to exercise control.

In the reply from Cincinnati attention is called to the fact that some cities are having much trouble from promoters who are inclined to build without regard to any city plan or any consideration other than quick disposal of their lots, and that legislation intended to curb this practice has been drafted but has not become a law.

The authority of the planning commission with respect to subdivisions exists also with respect to plans for territory outside the city limits and within three miles thereof.

Detroit, Mich. Detroit has a city plan commission and all plats for subdivisions, before reaching the common council, which appears to be the ultimate authority for approval, must be first submitted to and approved by both the city-plan commission and the city engineer. The city charter which creates the city-plan commission provides that it shall include an architect, a civil engineer, a structural engineer, a real-estate dealer, a builder, an attorney and a physician, all citizens and residents of the city. This commission is not only given power to determine whether property shall be acquired for streets, parks or boulevards, and street widening, but shall also "pass upon the acceptance of all plats of land within and for a distance of three miles beyond the limits of the city."

In the report received from the consultant-secretary of the city-plan commission, there is no reference to the filing in any office of record of these plans other than submission to and approval by the common council. In the case of plats covering territory outside the city and within the three-mile limit the board of county auditors has adopted quite generally the methods of the city-plan commission and, as they approve all plats within the county, the city has seldom attempted to exercise control beyond the city limits.

It is further stated that real estate developers, almost without exception, conform with the regulations adopted by the commission. It is suggested, however, that there should be specific provision for the submission to and approval by some city department before any plats should be placed on record and the city-plan commission is the one naturally suggested.

St. Louis, Mo. A state law enacted this year prohibits the sale or offering for sale in any city of 400,000 inhabitants or over of any lot or parcel of land shown on any plan of subdivision unless the plan shall first have been recorded in the office of the recorder of deeds. It further provides that no such plan shall be accepted for record unless it shall have been submitted to and shall bear the approval of the authority having charge of the design or construction of streets. That authority in St. Louis is the board of public service. The city also has a city-planning commission which commission and the board of public service work in cooperation and have together framed rules governing the preparation and filing of subdivision maps. These rules have not yet been adopted but are still under consideration and have been submitted to the Real Estate Exchange for criticism and suggestion. The proposed rules describe in detail the information to be given on preliminary and final plans and the scale to which they shall be drawn and fix a minimum width of 50 ft. for streets and 20 ft. for alleys. No block shall be over 1000 ft. in length. It is also specified that due provision shall be made for continuing such existing streets of adjoining subdivisions as may be necessary for public requirements. The filing and approval of such plans shall constitute a complete dedication.

St. Louis has no authority over subdivisions beyond the city limits.

From the fact that the proposed rules have been sent to the Real Estate Exchange it is evident that cooperation by the real estate developers is expected.

The committee feels that the information secured by it justifies the following conclusions and recommendations:

1. There is an obvious need of better control of property subdivisions as well as of other details of city planning. Its primary purpose should not be to regulate dedications but to insure a proper plan and orderly development.

2. Such control should not be vested in legislative bodies, such as city councils, but in officers or commissions whose responsibility for the development and carrying out of the city plan is clear and unescapable.

3. Legal provisions relating to the subject should be incorporated in city charters or in statutes relating to all cities of the same class. They should not be in special laws, disguised as general, by making them apply, for instance, to cities of not less than 100,000 nor more than 105,000 population.

4. Jurisdiction over subdivision plans should extend to territory which is likely to be annexed to the city tho now outside the city limits. In cases where two or more cities or towns are contiguous, or so near that extra-territorial jurisdiction would overlap, regional planning authorities or metropolitan planning boards are highly desirable.

5. City-planning commissions should not be too large and should include, as ex officio members, certain responsible city officials, especially the city engineer. The members, other than those designated ex officio, should have overlapping terms to insure continuity of policy and purpose.

6. Every city and town should have a planning board or commission, those which are contiguous, or nearly so, being combined in one jurisdiction under a regional or county board.

DISCUSSION

MR. TILLSON: There was one thing in the paper that reminded me of something that happened in the West. If a property owner had any property within the city limits that he wished to lay out into streets and lots he divided it up and called it an addition. Finally, there was an amendment passed which provided that no addition should be authorized by the city council until it had the approval of the city engineers. The property owners were equal to that, however. They had ordinances passed condemning the streets, in direct opposition to the city laws.

MR. HOWARD: Could Mr. Lewis briefly state whether or not the subject is now more appreciated and whether real progress has been made on the whole in city planning in the United States.

MR. LEWIS: Let me say that the real progress which has been made, and the keen interest in city planning which has been developed during the last decade is very gratifying. It is as much as could have been anticipated by any of those who have been paying especial attention to this particular subject. One phase of city planning that is arousing much interest over the country is what we call zoning. The purpose of zoning is, as you know, to control in the interest of the city as a whole and of each individual citizen the use to which property may be put, the extent to which each plot may be covered by buildings, and the heights to which buildings may be carried. Each one of these intimately affects one or more of the special kinds of municipal work which may be the subject of discussion at the annual meetings of this Society and of intensive study by its several committees between such meetings.

In the first zoning plans and ordinances which were adopted, there was evidence of timidity and uncertainty as to how far they should go in the imposition of restrictions; what limitations the public would be disposed to accept, and to what extent they would be sustained by the courts. The property owner appears to have appreciated that any loss thru restrictions imposed upon him is more than offset by the restrictions imposed upon his neighbor, which prevent the latter from creating a nuisance or from using his property in a manner inconsistent with the character of the neighborhood as fixed by the zoning plan. So generally have the advantages of zoning been appreciated that it is apparent that the plans first adopted could with safety have gone much further than those formulating them ventured to go. It is now recognized that it is perfectly reasonable to insist that industries which involve the creation of smoke, fumes, odors and excessive noise, should not be permitted to invade districts devoted to homes. If this be accepted as a proper restriction it would appear logical that where certain districts are set apart for what might be described as "nuisance industries," the building within them of homes for human occupation should be prohibited. In other words if conditions inseparable from certain industries are prejudicial to health and comfort and are not permitted where people live, then people should not be allowed to live under conditions which are so unfavorable to decent living as to warrant their exclusion from districts devoted to residences. While such restrictions have been suggested and in a few cases perhaps incorporated in plans already formulated, the fact that they have been accepted as reasonable, even in a few cases, shows to what extent this phase of city-planning is being generally accepted.

CHAIRMAN RANKIN: We had an instance of that in our own city about a year ago. One of the large manufacturers there proposed to build a large number of small houses for his working men within the heavy industrial zone, which is the nuisance zone, if you may call it that. After a great deal of discussion the board of commissioners were wise enough to turn the proposition down, and the houses were not built.

REPORT OF THE COMMITTEE ON CITY PLANNING
SUB-COMMITTEE B—ZONING

Joseph W. Shirley, Chairman, Baltimore, Md.

The committee respectfully submits this report for 1921. The members feel that it is necessary to explain in detail how a zone plan is evolved and some factors which determine the plan. Examples of its influence on various phases of municipal improvement are given to interest the engineer in order to secure his cooperation to promote zoning for all cities.

The earliest attempts at what might have been called zoning in the United States, were for the protection of residential neighborhoods and real estate values from invasions by Chinese laundries. Numerous cases of this kind could be cited, particularly for the state of California. There came to be another point of view, another reason for adopting regulations that are now known as zoning. This is best illustrated by a resolution of the Board of Estimate and Apportionment of the city of New York, adopted Feb. 27, 1913, as follows: "Whereas, There is a growing sentiment in the community to the effect that the time has come when every effort should be made to regulate the height, size and arrangement of buildings erected within the limits of the City of New York; in order to arrest the seriously increasing evil of the shutting off of light and air from other buildings, and from the public streets, to prevent unwholesome and dangerous congestion, both in living conditions and in street and transit traffic and to reduce the hazards of fire and peril to life. . . ."

The New York zoning ordinance resulted from studies made pursuant to the passage of the foregoing resolution. It was designed primarily to protect:

a. The public health by conservation of adequate light, air and quiet rest and by prevention of congestion.

b. The public safety, by promoting protection from fire and panic and by decentralization of population.

c. The general welfare by assuring more comfort and convenience, by reducing street congestion, by safeguarding property values, by maintaining the character of a community, and by adopting a rational city plan which included a zone plan.

Zoning for the Engineer

Since some of the original conditions and reasons for zoning have been set forth, it is the intention now to discuss the districting principle in its relation to the engineer and his problems. Is it good policy for a city to say that all the buildings within a certain district must be devoted to residence use, or that the land

and buildings within another district may be used for industrial purposes, and that they may or may not be used for residence? It is of importance to the highway engineer who is concerned with paving the street, to know that said street will run thru what will become an area given over almost exclusively to heavy industrial use that requires heavy trucking? Is it of interest to the highway engineer to know that a street will run thru a district henceforth to be used for residence? Is it of vital consequence to the sewerage engineer to know the probable population which a sanitary main will have to serve? To the harbor engineer does it matter if dwelling houses are built along the waterfront where piers, warehouses and freight yards logically belong? Would it be interesting to the water engineer to know that an existing residential neighborhood in which he had laid a five-inch water main, might some day be invaded by factories consuming considerable quantities of water, more than could be supplied by a five-inch pipe? It is intended here to answer just such questions as the preceding ones. Zoning deeply concerns every branch of engineering and everybody who is interested in municipal improvements.

Topographic Map Most Desirable

Before any engineering project can be planned and carried out it is necessary to have a map on which to plan. Fundamentally then a map is requisite. What kind of map ought it to be? One which shows no elevations and is not drawn to scale is not worth much. If it is the intention to prepare a map which will be of permanent value in directing the growth of the town, one to be used as a basis for the study of a comprehensive city plan, including a zone plan, if it is to be a map on which the sewerage engineer can design an elaborate sewerage system, if it is to be a map which the highway engineer can use in studying grades, there are certain requirements which such a map must meet. From experiences covering a period of about twenty-eight years, during which the well-known topography map of Baltimore was subjected to all of the above mentioned tests, it seems that for a practical map for a diversity of uses, the scale should be not less than two hundred feet to one inch and that contours at five-foot intervals are necessary. Indeed, where the terrain may be flat, contours at one or two-foot intervals are very desirable for sewer studies.

Zoning Part of City-Planning

Zoning is now considered part of any comprehensive city-plan. Hence the general street plan, park system, and zone plan should be studied simultaneously and cooperatively. It is interesting to call attention to the fact that in the city of Baltimore where the American Society for Municipal Improvements is now in convention assembled, ideal conditions are prevailing. Sixty square miles of new territory has recently been annexed to this city. A topographic map covering the original thirty square miles of the city is already available. This map is being extended to cover the new addition. A street plan is now being prepared upon this foundation, and simultaneously the zoning commission is preparing the zone plan. These two great schemes are running concurrently. This kind of coordinated planning is the ideal toward which all engineers ought to strive. To the city-plan engineer or the zoning specialist, it is the opinion of this committee that wherever it is possible to do so, by all means try to secure an adequate, workable topographic map on which to draw your plans. Work them out at the same time, keeping in mind their rational inter-relation. This procedure will give you the very best results.

Housing Survey

A housing survey is indispensable as preliminary to drawing a zone plan. The data should show the use of every building, the number of families dwelling in each house, the number of rooms in each house and it is desirable for statistical reasons to secure the exact number of men, women and children. The survey ought to show the vacant houses and the occupied ones, those occupied by owners and those rented and the amount of rent paid by tenants.

The housing survey will show the number of retail shops necessary to accommodate a certain population. In various parts of the city the number of stores for a constant population may vary. The same source will enable a tabulation of the present total population, the number of people or families per acre in any section of the city or in any particular kind of housing development. Therefore, having the percentage of people who live in the various types of residential uses, and providing a reasonable future residential distribution based on an estimated population for the whole city, the number of local shops that the residential districts can support may be estimated. On that assumption, local business zones or community business centres are selected after public hearing and due consideration given to existing conditions, to counsel of residents and property owners.

Fundamental Work

The principal means by which districting or zoning is accomplished are restrictions on the use of land and buildings, restrictions on the height to which buildings may be erected and the percentage of the area of their lot which buildings may occupy, qualified by front set-backs, side yards, rear yards, etc. When the base maps become available for zoning studies, certain information must be obtained, showing the existing conditions in the city. One set of maps must be made which accurately depicts the use of every building and parcel of land. This is known as the existing-use map. Another set is compiled showing the different heights of present buildings. A set of maps is prepared illustrating the per cent of the lot covered by each existing building. This is known as the occupancy or area map. A valuation map is prepared picturing the assessed valuation per front foot of all the land. This last mentioned diagram is very important for, land values in the down-town section being very high, it will be reasonable to permit buildings of greater height in that district. With these maps for references, the predominating use and height of any block in the city can be determined.

Business Use

In the central part of town will be found the business district. It will contain the highest office buildings, most of the hotels, many of the public buildings, some tenements, few one-family residences, much light manufacturing, the wholesale district, a large warehouse area, certain factories and heavy industries, and even some industries of the nuisance type, which emit gas, fumes, smoke, odors or dust, or which produce excessive noises. An area is outlined as the logical central business district based on the existing conditions as shown on the map and by inspection in the field with study of property values, location of probable contiguous residential property in an effort to avoid in the future blighted districts, the probable business expansion in a reasonable period, a decade, score or generation, based on statistics. Consideration must be given to the advice of engineers, to the opinions of business men, real-estate authorities, architects, and city-planning experts. Due care must be given to the bearing on the proposed business district of street-car service, rapid-transit possibilities, street widths, congestion, size and situation of sanitary and storm-water sewers, water mains, electrical conduits and the location of railroad terminals.

Business is not confined to the central down-town district. It follows out the major streets and is found too in local business centers as well as scattered promiscuously thruout the residential sections. Zoning endeavors to confine it to logical places. It is quite natural to zone portions at least of the major streets, which in the majority of cases are those carrying street-car lines, as business thorofares. So much of them as are devoted to residential use ought to be so restricted, to be subject to a changing use when required for business expansion.

Industrial Use

The present industrial locations having been platted when the use map is made, a list of industries is made after careful study and inspection of each plant. This contains all business which it is desirable should not be in the mercantile business zone above determined; for example, railroad freight yards, foreign steamship piers, brick yards, lumber yards, factories, etc. A questionnaire ought to be prepared and sent to those vitally interested in the industrial growth of the town. The answers will give the consensus of opinion of the ones who are financially affected by the location of industrial development. After public hearings are held, conclusions are reached. Outlines of the proposed industrial zones are drawn based on the situation of present industries, and on the future industrial growth of the city as near as it can be predicted. It is safe to say, on general principles, that the natural distribution of the industrial zones will be along the railroads, around the harbor, on certain low swampy land in the valleys, and on land especially adapted for certain purposes such as brickyards and quarries. Topography is an important factor too. High ground away from ready means of transportation would not be suitable for industry but rather for residence. Ravines, rocky slopes and certain forested areas should be preserved for possible parking. The existing water mains for domestic consumption and fire protection, possible high-pressure water service, sewer facilities, accessibility by haulage highways, and street-car service are all fundamentals to be considered. Zones for industry should be so situated that they may be approached without the necessity of grade crossings. They should be in an area which is in close proximity to rail and water transportation facilities. The land values are important. Housing conditions or possibilities and labor supply are influential factors. The industrial zones having been determined, non-conforming uses may be permitted until a change from that particular use is desired, when the established use becomes effective. Opinion differs as to the advisability of permitting residences in industrial districts. Business of the mercantile type is usually allowed there.

Nuisance Use

The list of industries just prepared will show certain manufacturing plants that by reason of the emission of smoke, gas, fumes, odors, dust or distracting noise, will be injurious, obnoxious or unhealthy in the midst of other industries. These are called the nuisance uses. They may be in certain situations injurious to other industries and yet not necessarily a nuisance *per se*. In the great industrial organization of the world they are necessary uses. They must be provided with a place in which to operate. It is to their advantage to be situated apart from other uses where they may be free from annoying and hampering restrictions. One controlling factor of paramount importance is the direction from which the prevailing winds blow over the the city. Ideally situated, they would be placed on the leeward side of town so that the gas, smoke, etc., the annoying feature to the health, comfort, convenience, safety and general welfare of residents and less offensive business or manufacturing, may be blown away from town and dissipated harmlessly beyond. The weather bureau has records available, covering a long period of years, from which requisite studies can be made of the direction from which the prevailing winds blow. Manufacturing of the nuisance class requires transportation facilities. Perhaps disposal facilities for waste will be necessary. It seems reasonable and it is the best practice in recent zoning ordinances to exclude residents from the nuisance zones for the protection of health.

Residence Uses

The residence district must next be determined. If it may be assumed that the business, industrial and nuisance zones have been fixed, the rest of the city may be allocated to residence use with the possible exception of what might be termed an unrestricted or undetermined zone where it is not possible with sufficient degree of certainty to say just what would be its use if not subject to regulation or for what use it may be required. In general, residence zones include every type of building used for that purpose. They will include areas which will logically be developed by rows of two-story brick houses so common to some of the eastern cities. In this district will be also what might be termed semi-detached houses, that is, houses built in pairs with one side yard for each unit. Detached cottages surrounded by open space are another type of residence. Apartments or multiple-family houses, sometimes known as tenement houses, as well as undeveloped land for future residence purposes, will be found in this zone. It will include dwellings for one family, for two families and for three or more. There might be permitted in some of the residential zones, doctors' and dentists' offices, perhaps home millinery, dressmaking, hairdressing, manicuring, churches, hospitals, schools, denominational and eleemosynary institutions. In protecting a neighborhood for residence use there is an opportunity to exclude bill-boards except for specifically advertising the real estate on which they are situated, because they may be interpreted as a business use which is prohibited in that district

Height Limits

When the uses for the various districts have been determined, the next step in guiding the growth of building development is a study and limitation of heights to which buildings may be erected for the various kind of uses. In the business district, among the things which must be considered when fixing height limits are, fire hazard, health, congestion both in buildings and on the thorofares; land values in the congested district, injury to abutting property, increasing cost of high buildings per cubic foot, the most economical height for income-bearing investment for different uses, the angle of light, street widths, length of shadows cast by high buildings on east and west streets at noon on the shortest day of the year, shades and shadows varying with heights and the angles which other streets make with the meridian, necessity and cost of artificial illumination of buildings, all available statistics on high buildings, opinions of those who own them and of those who are authorities on real values and heights. For the downtown business districts a reasonable height limit must be ascertained and adopted. It must be a flat height-limit of a fixed number of feet over all, a maximum height for the cornice line, a limited number of stories or it may be dependent upon the width of the street in question. The aim is to spread out population concentrated in the congested section by keeping down height-limit. By lessening centralization traffic is thereby facilitated. Height-limits suitable to the localities may vary for business zones along major streets and at local business centers. The ordinary limitation of height will not apply to towers, spires, smoke stacks, standpipes, aerial stations, etc. They are subject to special rules dependent upon their area at the base in relation to the area of their lots.

In residential districts the height-limit is intended to promote the health, safety and general welfare of the dwellers therein. For these reasons it will vary for each class of residential use. The common row of two-story brick houses, the semi-detached house and bungalows may have approximately the same limitations on heights. It is equitable too to provide for the erection in certain localities of three-story houses. These types just mentioned may be confined to one-family zones or they may found within the zones where two or more families are permitted. The height-limit for areas wherein apartment houses are permitted should be determined with due consideration for a factor of safety to insure fire protection. In general, apartment houses may be permitted in every class of residential zone where they can conform to the height and area restrictions, except in zones specially reserved for one and two-family dwellings. Exceptions to residential height-limits include churches, steeples, monuments, domes, cupolas, etc.

A limitation on the height of buildings within industrial and nuisance zones is not so necessary. They are located where land values are not exceedingly high, they usually have good fire protection and they automatically limit their own height for efficiency and economy in construction and for manufacture of their various products.

Area of Lot Covered

Reference is now made to the existing-area map to ascertain the general practice within the city for each kind of use. In the central business part of town, land values, some attention to light and air, and the use for which the buildings were erected have up to this time determined the area covered. In a proposed scheme for limiting the percentage of the area of its lot which a building may occupy, many of the factors which determine height are applicable here. Street widths and possible congestion must be considered. Corners probably permit the highest per cent of occupancy. Inner lots ought to have a lower percentage with probably requirements for courts or rear yards, qualified by frontage on alleys.

The types of buildings in industrial zones vary so widely, having been erected for so entirely dissimilar purposes, in fact railroad freight yards and ground storage space are so prominent in these zones that it seems almost unnecessary to place an area limit on them. Fire protection would be perhaps the only important factor that might cause limitation. Area regulations affect most noticeably the types of buildings which may be erected in residential zones. For certain reasons it will be advantageous to the owners for apartment houses to be built in the closely built-up parts of town where they may occupy a larger portion of the lot, thus giving greater rentable floor space. They may be built in the less densely settled sections providing they can conform to the height and area limits and do not conflict with the one and two-story family restriction. It is desirable to permit the prevailing rows of brick houses in the future and certain zones for them ought to be provided with an area-limitation of about fifty per cent of the lot with possibly front or back yards, or both, stipulated. To protect the present detached dwellings either in future one-family or two-family districts and to encourage a continuation of that class where it is desirable from the residents' and land owners' point of view and for the general welfare, area zones are selected where the buildings may cover thirty per cent of the lot with regulations requiring front, side and back yards.

One-Family Districts

It is highly desirable that sections of the city where the one-family house predominates should be protected and perpetuated. This meets a social problem and is a means of solving it. To make good citizens the working man should be encouraged by this protection to acquire the ownership of a home where he may be surrounded by people with the same ambition to advance. They have an interest in their home. They have an interest in their representatives whom they select for the governing body of the city and whose actions react upon the home owner and tax payer. The home owner is a wholesome citizen who helps to stabilize labor conditions in his community. He is a bulwark against bolshevistic tendencies now so rampant. Bolshevism is powerless to cope with the satisfied home owner of our country. He has at stake his greatest interest in life, which he will not jeopardize. The committee strongly recommends liberal provision for one-family residence zones.

Results of Zoning

The engineers of the American Society for Municipal Improvements who have been busy with the varied construction work may not have considered zoning so very essential to their several branches of engineering. Reference has been made in this report to major streets, to grades, to heavy-traffic streets, to sewers, water-mains, electrical conduits, harbors, grade crossings, railroad terminals, street-car service, congestion of population and traffic, fire-hazard, health and safety and to parks. Zoning vitally affects all of these and many other necessary city improvements.

Originally cities were built along waters of bays, gulfs, etc., where safe harbors were found for anchorage of ships, or along the shores of navigable rivers. To most of these cities came railroads or the railroads emanated therefrom. There was a natural limit to the number of available harbors and of necessity people sought other sites for towns. Working simultaneously was the tendency to seek raw materials at their source. Agrarian pursuits carried some people to the farms. The earth's deposits of rich ore and coal attracted others. Railroads reached out and at places crossed each other. Their junctions became centers of business life and were suitable locations for towns. People settled near other people for purpose of trade. Cities grew up then both on navigable water and inland as a result of commerce. It is well to say they "grew up." Few had the advantage of a plan in the beginning. Studies have been made and on analysis it is found that the harbor and railroads form the basic growth of the city. The streets are the skeleton or framework about which and between which the buildings are built to complete the body. In the streets, along them, under them and above them are the people, the houses, the street-cars, vehicular traffic, sidewalks, roadways, parks, sewers, water and gas-mains, electric wires, etc., which are the soul, mind, arteries, veins, nerves, alimentary canal, etc., of this great body we call the city.

Harbor

What has zoning to do with engineering? The harbor is the thorofare over which boats travel. It must possess ample width for moving vessels to pass one another or to turn in. It must provide anchorage for ships which are parked, so to speak, on the highway. Depth of water is an essential desideratum. Around the harbor should be planned bulkheads, docks, piers, with loading and unloading facilities to accommodate overseas steamships, coastwise vessels and bay or river steamers. Terminal adjuncts are necessary for a comprehensive plan. These include great storage warehouses, railroad sidings with supporting car-storage yards contiguous. To provide adequately for maritime commerce a port ought to have its water front reserved for the use of shipping. This is a form of industrial use which seaports require. It would be wasteful of the shoreline, inefficient and uneconomical for factories which do not use or require marine transportation to be situated on land necessary for present or future harbor development. To a greater degree would a misplaced use result were the water front given over to dwelling houses. Swamps, low, marshy lands and muddy flats which in their present condition are unavailable for commercial purposes may be consolidated with the fast land by pumping material dredged from the channels and the anchorage basins. Two processes are going on simultaneously; deepening the navigable waters and making land, which land may be zoned for industrial use or, dependent upon its remoteness from the city and its need for industrial growth, that may be the site of a waterfront park like Potomac Park in Washington.

Railroads

The railroads are immediately concerned with the harbor. The two means of transportation must be coordinated. Freight from inland is brought to the seaports and imports are carried away by the railroads. They serve to transport to the cities goods for local distribution and to take away the cities' manufactures. Local freight lines and terminals should be frequent and well distributed. A municipal belt-line, with switching facilities to all independent roads should circle the harbor and gird the outskirts of the city where possible. Shippers will there have advantageous hauls to their loading points. Thru freight requires special attention. It should be routed over its own tracks, around the congested areas. It brings nothing to a city en route. If it is retarded in passage or if it serves to delay local freight, it is merely conducive to higher prices to the ultimate consumer of the freight carried. Hence if thru freight be carried around the centres of population, it reaches its destination with greater dispatch and lessens congestion in the city. A unification of the railroads entering a city is preferable so that they may operate thru freight over the same tracks and work out all their problems cooperatively, with the least expenditure of capital.

Zones are necessary for railroad service. They should be in the industrial district and be assured of a safe place in which to concentrate large permanent investments, unhampered by restrictive regulation such as is necessary for residential use. To the railroads and industries requiring railroad facilities, should be allocated zones situated with reference to the existing railroad and industrial locations, dependent upon the topography and the natural routes for ingress and egress. Many blighted districts either built up or undeveloped, such as are commonly seen along railroad rights of way, will be prevented by knowing where the industrial zone is.

Grade-Crossings

Grade-crossings are a menace to life, they are costly, and they are annoying to vehicular movement as well as to pedestrians. The elimination of grade-crossings should be one part of any railroad and zoning scheme. The danger to traffic and liability to the railroads for accidents ought to be overcome. Supporting classification and storage-yards together with thru freight and fast passenger lines ought not to be crossed at grade. The major street plan only should cross the above named railroad zones at reasonable intervals of perhaps one-half mile and not at grade but where topographic conditions give an opportunity to build an overhead structure or a crossing underneath. These suggestions are for the railroad as well as the city engineer.

Bridges

Closely associated with railroads and the harbor and its tributaries as well as with the street system is the branch of bridge engineering. There are the highway or other engineers who are to say where the bridge is to be built. Its location is traceable to zoning, for the use of the property in any locality will have much to do with the location of the bridges that are to serve it. The bridge designer is interested to the extent that he must know the kind and amount of traffic it will have to carry. That can best be determined by study of the use assigned to the districts on either side of the bridge and not only near but at remote distance therefrom. The strength of structure required and the width necessary to care for the probable flow of traffic for a long period of years are dependent directly upon zoning. Many cases are on record where highway bridges were designed and built before adoption of major street and zone plans. It is a common occurrence to have to strengthen, widen or rebuild bridges that will not carry the load that they are now called upon to carry. Why? Because a major street now leads across them, or building-development for residence or industry has entirely altered what seemed to be a reasonable estimate when the structure was built. Notice is hereby given that a setting at both ends, to enhance the beauty of the bridge and even for protecting its foundations and approaches, can be had by zoning the abutting land for park in the interest of the general welfare or at least by keeping the business or industrial zone at a reasonable distance from either approach. This restrictive regulation may accomplish what every bridge designer, city planner and landscape architect desires, namely, a suitable setting for a fine bridge.

Street Plan

Some reference has been made to street plan and major streets but it is necessary to discuss them further. The skeleton upon which the circulation of the whole city depends is the major street plan, arterial street system or thru-traffic streets. They will be the heavily traveled ways in moving from one part of town to any other remote part. They should be broad highways which radiate from the center of town much like the spokes from the hub of a wheel. They should follow routes as direct as possible, consistent with good practical grades for heavy hauling. The radials ought to be tied in, at reasonable intervals of about one-half mile, by circumferentials, diagonals and cross-town thorofares. Easy access is thus given from any part of town to any other. The major streets are those along which the great bulk of traffic moves. Therefore business is attracted to them. For many reasons then it will be found desirable to zone them or portions of them as business streets. With the inevitable, increasing use of such arteries, they become less and less desirable for residence, because of noise, dust, odors, unpleasant aspect and lack of seclusion. Some major streets run to and thru industrial aspect and lack of seclusion. Some major streets run to and thru industrial zones and will never be subject to a passing residential use. Major traffic streets should never be laid out less than eighty feet between building lines. They should probably be, in round numbers, 100, 120 or 150 feet wide, depending on the amount and kind of traffic they may be called upon to carry, the districts they pass thru and their importance in the street system. Minor streets will be residential, local, business, or industrial, depending upon the district in which they are planned. Their width should be from forty to sixty-six feet.

Elastic Streets

The principle of "elastic" streets ought to be studied and applied where possible. This means that the building lines should be fixed by condemnation, by a new building-line ordinance or by set-backs under the police power that is used in zoning to require front yards of a certain depth in certain districts as under the area-restrictions for light, air and general welfare. The new-building line is of a width ample to provide adequately for increased traffic for several generations. It is not entirely paved however, but only as much is paved as is required to carry the probable traffic for about the life of the pavement. When repaving is necessary, the width may be increased if required. The same process may repeat several times. The portion of the street not paved should be parked by planting hedge, grass, flower beds and trees. The trees should be so placed as to form an integral part of the final treatment when the street reaches its ultimate width of paved roadway. Certain streets subject to elastic treatment will be zoned for the present as residential; subject to a changing use when they are required for business expansion. Fixing building lines by ordinance or by set-backs as part of the zone plan will save much of the cost of condemnation. The set-back will legally prevent buildings being erected within what will be required for the future street bed. Zoning and traffic undoubtedly determine street widths for the city-planner. He must plan widths suitable for territory which without guiding regulations has zoned itself and he can with a reasonable degree of assurance, plan for zones established by ordinance.

Street Paving

The paving engineer may wish to pave a street. He knows the kind of development thru which it passes now, but he assumes certain things such as the stability of the present use and the probable use of the land beyond. If he knew that the street were to serve a permanent residential development, even as a major thorofare, he would use a certain kind of paving material. If he knew that it led to a future industrial zone that would require heavy and frequent trucking, he would use another material perhaps. The weight of the probable load would at least determine the thickness of the foundation. The light, smooth, noiseless, and dustless, pavement so well suited to minor residential streets is not well adapted to heavy hauling. The very feature that makes it desirable for light hauling is what makes for slipperiness in wet weather. So heavy granite block pavement on an eight-inch concrete base would be necessary for heavy and frequent loads. Until the industrial district is built up, perhaps a lighter wearing surface may be laid on a heavy base. The local residential street should be paved to a width sufficient to carry local traffic only. It is desirable to discourage heavy thru-traffic in order to preserve the quiet enjoyment of a residential neighborhood. The width of the heavy-haulage highways is intended to accommodate immensely increasing vehicular traffic and that might include street-car service too. A zone plan will determine the kind of streets and their classification which in turn will recommend the paving material and its width.

Street Railways

Transit problems may be simplified by an effective zoning ordinance. If it is known what kind of zones are to be found in a section, the transit requirement may be determined far in advance, just as the major street plan is laid out. Obviously, if a car line serves a high apartment-house zone, there will be more people per acre to be transported than maintains in a single-family detached-house district. Similarly if the railway company knows that in a certain place will be factory uses, it knows how to determine service. For efficiency and economy as well as convenience to passengers, it would be an ideal condition if factories were located on the outskirts of town. Then cars would carry a capacity haul each way. In the one instance, factory workers would come into town, get off as the cars pass thru their residential districts, transfer at junctions or come to the center of town for distribution among other car lines radiating therefrom. In the second case, the same cars would travel away from the congested district with the office workers to their respective destinations. With street-car service improving all the time, residential zones may be situated farther from the industrial and business centers, spreading out population and enabling the people to enjoy freer, healthier living conditions.

Zoning for Sewers

A comprehensive sewerage system and disposal facilities are inseparably linked with any zoning scheme. The business zone will have practically one hundred per cent run-off and storm-water drains must be designed accordingly. The area restrictions in the residence zones will limit the percentage of the lot which may be covered by buildings. Hence with due consideration for uncovered area of lots, for widths of roadways, sidewalks, parking strips, geological conditions, topography, grades and rainfall, a reasonable run-off may be determined for each area zone and size and location of storm water inlets and drains calculated. Sanitary sewers are designed to care for population. The downtown business district will have a height limit greater than the residential zones. In the high office-building zones, where population per acre is greatest, must be built the largest sanitary sewers. In the parts of town where apartment houses will be permitted, sewers are of another capacity. In residence districts set aside for one-family houses closely built in rows, or in the detached neighborhoods, suitable capacity drains must be designed. It would be eminently desirable for the designing engineer to know the kind of buildings to be erected in any part of town, thus giving a reasonable opportunity to estimate future population and to make his layout accordingly. Much time and money can be saved to a municipality if sewers can be designed and built that will perform the service required of them instead of having to replace drains that are too small for a duty which was not foreseen when they were built. Depth, length, and size, the controlling factors in cost of sewers, are more readily determinable under zoning regulations. Sewage-disposal facilities are based on population estimates. These are just as important to the zone engineer. If it can be estimated with some degree of accuracy, future populations, based on past growth, industrial and housing surveys, a disposal-plant may be built to accommodate a given population and can be designed for future expansion.

Water Supply

An illustration from the experience of the water engineer of Baltimore will serve to indicate the desirability of zoning to this department of municipal engineering. A certain old residential district was served adequately with a six-inch main. Into the neighborhood came factories which properly belonged in an industrial district. The water department had to install a ten-inch main to give necessary fire protection and domestic service. A total expenditure of nearly $12,000 was necessary in about two city blocks, solely because of industrial growth in a residential section of town. This is only one example. Others will come to this city and to many cities until a comprehensive zone plan is available to guide the engineer.

Fire-Protection

Fire-protection and water-supply are inter-related. The former can be more readily determined if it is known what use will be made of the property. High-pressure service can be provided for by water mains of sufficient capacity in the business and industrial zones. Lack of water, so familiar to firemen, ought to be overcome.

Other Public Utilities

Kind of development and population requiring service, determine largely facilities requisite for municipal electrical conduits. The gas companies require similar information when laying gas-mains to determine location and sizes. Street-lighting systems are influenced by all the elements that determine a zone plan. To the telephone companies zoning would be of inestimable value. Periodically they make surveys to estimate the probable telephone service required for a number of years in advance. A survey was made in a certain city this year on which to predict their requirements until 1940. They assume that particular kinds of development will go in the various parts of town; that there will be a certain population at any year; that to house the people, an estimated number of houses will be necessary; that they will be rented or owned by the occupants and that in a given locality rents will be at a figure based on what their housing survey shows to be the rent for that type of dwelling. Statistics show what per cent of the people who are able to pay a certain rent, have telephone service. Therefore they get a reasonable idea of the number of telephones required, of the number of trunk lines, of the size of their conduits and of the capacity of their plants and exchanges to serve the city at some time in the future. All this is based on a hypothetical development which may change and probably will in many cases unless zoning fixes the use of land and buildings and the distribution of population. Zoning stabilizes property values which in turn would be reflected in uniform rents, tending to make the telephone company's estimate more certain.

Schools, Libraries, Police, Fire-Houses, Public Baths and Markets

Population distribution studies necessary for zoning will be important in locating schools for maximum efficiency, for locating public libraries, for the selection of sites for police stations, for fire-engine houses, for fire-alarm stations, for public baths, and to show necessity for markets in various sections of the city where none may be established. This last suggestion is important for it seems that all the markets in some cities are very close together in the down-town district when there should be some in the local business centers in residential sections.

Street Cleaning and Garbage

To those who are interested in street cleaning and the collection and disposal of garbage, the committee would say that the disposal plant ought to be erected in the nuisance district or beyond it. Suffice it to say that it should be on the side of town opposite to that from which the prevailing winds blow. As for street-sweepings and ashes, they are available for filling in low or marshy land desirable for industrial growth or for reclaiming waterfront land. This collection ought not to be dumped haphazard in any nearby ravine which may be desirable in its natural state for parking.

Parks and Recreation

A zone plan would consider the park system and at least preserve it from encroachment by industry. The time may come when the courts will recognize a recreational use in a zone scheme. The open spaces, such as playgrounds and parks, are as important as residential or commercial uses. Land along non-navigable streams, in wild ravines, or on steep slopes is not readily adaptable to building purposes, yet it makes admirable parking. Certain wooded areas are beautiful and should be part of a park system. Playgrounds are necessary for the little ones and recreation centers ought to be set aside for all the people. Suitable park lands may be zoned as residential and at least protected from industry, depending on its undesirability for residence to hold it free from exploitation until it can be acquired as part of the park system. This is not an ideal solution but may be of service until the courts will uphold a strictly recreational use to secure to the people light and air for their health, safety and general welfare.

Other Advantages of Zoning

Books could be written on the inestimable value of zoning for preservation and promotion of health. Stabilizing of property values will result from operation of a zone ordinance. Real-estate men will verify this and heartily endorse districting. A farm or gardening use might be a means of establishing districts where profit may be obtained from the land until a changing use is necessary to open it for development. Taxation will be simplified. The taxable basis should receive an impetus upward to be reflected in a lower tax rate.

The committee recommends that engineers concerned with municipal improvements and public service note all the details contributing to the determination of a zone plan and consider carefully the relation of such a scheme of directing city's growth to their several branches of technical work. Zoning is a science and as such ought to be coordinated with all scientific planning.

THE ADVANTAGES OF A TOPOGRAPHIC MAP IN CITY PLANNING AND ZONING

By Jefferson C. Grinnalds, Asst. Engineer, City-Plan Committee, and Secretary of Zoning Commission, Baltimore, Md.

It is a settled fact that a map of a city on which to study and lay out a plan for any proposed extension of the street system is necessary. It is a requisite too for replanning old parts of the city to systematically study traffic conditions, to show offsets that break the continuity of streets, to show bad angles, block distances, dead-end streets, inadequate widths and inefficient functioning of existing thorofares. A map of some kind on which to lay out a major street plan is absolutely necessary; and since zoning is an essential part of city-planning, its requirements must be supplied and maps are indispensable for a zone plan, indeed they are a part of it. There are many other reasons why a map of a city is necessary in planning.

Planning Without Sufficient Information

If it may be accepted as a condition precedent to studies for drawing a city-plan, that some kind of diagram of the present layout is necessary, then the kind of maps must be determined. Suppose those at hand are similar to the common well known automobile maps, which show merely street alinement depicted to a scale of approximately 2,000 feet to one inch or 1,000 feet to one inch. Of what service would a map of this kind be?

If it were noticed that there were in some places two parallel streets which ran thus for, say, one thousand or more feet without a connecting cross street, the city-planner might say "why not open between these two parallel streets, a cross town street which is dead ended on opposite sides of this long unbroken block?" He can see from inspection of the diagram what seems to be a desirable opening. It is not apparent from such meager information that the grade on the proposed connection would be as heavy as ten per cent. Why? Because there were no elevations given nor were there contours showing approximately the probable grade.

Imagine another problem that must be solved. Several parallel streets are shown on this diagrammatic map, crossing a railroad yard which lies contiguous to a railroad main line. There is no indication to guide the engineer in his diagnosis of the kinds of crossing over the tracks. Are they at grade, are they elevated above the tracks, or are they depressed below the tracks? If such crossings as exist are dangerous, what is the remedy? He cannot tell positively with no more facts to help the solution. If he had a contour map which showed the relative locations to scale, he would know at once the conditions on the ground and where to look to find the railroad in a cut or on a fill where the streets could cross overhead or underneath respectively. In one or both places he would advocate a bridge. Innumerable cases can be cited where it is absolutely necessary to have a topographic map, showing contours and surface detail for study on which to base a comprehensive city plan.

Kind of Map Necessary

From the foregoing, it seems that a map is necessary and further that it should be a topographic map. Assuming that to be a correct conclusion, the next step is to determine what the map should show. The first consideration is the existing street layout. All streets that are built up or marked on the ground should be recorded by the field survey parties and plotted on the map. Old lanes and drives should be included. The office force should be employed at the same time, compiling all the data accessible for platted parcels of land. Many such subdivisions have been laid out on paper with no streets having been staked off on the ground. All plats on record or of which any information can be obtained should be located on the field sheets when they come in. Improvements such as buildings of all kinds ought to be located on the field maps, including railroads, street railway lines, streams, shore line, lakes, reservoirs, retaining walls, dams, bridges, quarries and wooded areas. Fences and their character, such as wire, paling, rail, and old fence lines, hedges and rows of trees that might indicate old property lines, are requisite to a good map. The state of cultivation is desirable, differentiating by suitable standard signs, orchards, meadows, plowed land, corn fields, pine woods, etc. Lastly, contours must be located and plotted.

Scales

Having decided what physical features are to be shown on the topographic map, it is necessary to determine the scale and contour interval. The former ought to be one which is readily plotted in the field on a field drawing table. When it is remembered that rows of brick houses are to be shown, it is not practical to draw them at a scale less than about 200 feet to one inch. To be able to scale within a foot or two the width of a street or sidewalk, the above mentioned scale is almost the minimum. The well known map of Baltimore, made by the Topographical Survey Commission of that city in 1894, is a masterpiece of that kind of work. It is drawn to a scale of 200 feet to one inch, with a contour interval of five feet. It was found to be admirably suited as a base for working out a plan for streets in the hitherto unplanned territory within the city. The contour interval of five feet seems to be right for street design and determination of grades. It may be that over very flat terrain a lesser interval may be necessary for sewer design and to a lesser degree for water main locations.

Degree of Accuracy

Here it is well to decide how good the map must be from the point of view of accuracy. It should be based on a primary triangulation system, the stations of which may be regarded as nearly permanent and accurate to within ten seconds for closure of any quadrilateral. The secondary and tertiary stations should be almost as good as the primary. There ought to be one or two accurately measured base lines, corrected for curvature. On the triangulation there should be run out all the main roads and cross-country, a traverse control with a maximum error of one in ten or fifteen thousand. The reason for these standards of accuracy is that after such a map is complete, there is left on the ground a control from which detailed property surveys can be made, street intersections computed and established coordinately in the down-town districts where assessed land values are high. Traverse points should be iron rods or pipes placed in the most protected places along highways or in open country, or copper bolts set in curbs or on sidewalks, all well referenced for future use. A net of precise levels ought to be spread over the area to be mapped, bench marks placed on the most permanent structures at about half mile intervals. Wye levels can be run to traverse points and temporary stadia stations. Maximum error for precise levels should not be over about three-sixteenths of an inch to the mile.

Costly Errors Obviated

Why all this elaborate, detailed description of a map and what is the excuse for making it? Cities used to be laid out without one, it is true. What kind of a layout was it? Well, when a street was designed to be a straight street, it was so drawn on paper, so built on the ground and regardless of hills or ravines, it kept on. The costs heaped up for cuts and fills and bridges. If the way led to a railroad, it passed over at grade more than likely, leaving a heritage of danger for several generations, ultimately saddling the taxpayers with the burden of expenditures to eliminate at considerable cost, the death trap. Had a map been available, showing by contours the existing hills, valleys, streams, railroads, etc., it is probable that the entire street plan would have been different. When a large city of today was in the village or town stage, its whole scheme of streets would have been designed to fit the topography, had proper maps been made. The present small town should benefit by the costly lessons that the large ones have learned too late to greatly alter the down-town sections without prohibitive cost.

Steps in Planning

Take the initial stage—suppose a new city is to be built on a proposed site. The topographic map is made. It is possible to determine at once certain rocky, precipitous cliffs, bluffs, wooded ravines, steep hill-sides and other suitable areas for future parks.

These may be eliminated from the flat or gently rolling terrain so well adapted to building and over which a street plan must be studied. The old country roads, shown on the map, are the existing highways of travel. Some may fit in with a general scheme and others will not. A study will reveal the natural location of the points of ingress and egress for railroads. They will not come into town over the hills. They will enter by certain low grade lines and along them will be suitable territory for industrial development. On the higher ground will be the housing area. It is necessary to determine where the central business area should be. These various districts must now be connected. Radials from the center of town to the outlying sections must be provided. Cross-town and circumferentials must be provided. These streets are the basis for a major street plan. They need not be absolutely straight. The alinement may be determined by the contour of the ground, thereby giving easy grades but with the most direct route consistent with reasonable grades.

New Territory to be Laid Out and Old City Replanned

An old city that requires a plan for undeveloped or recently annexed territory and that needs replanning in built up portions, requires a topographic map. In almost every city of that type the street plan was drawn on a flat diagrammatic map. With the general information shown on a complete topographic survey, it is well to work out proposed extensions of the park system, reaching out into the undeveloped country, embracing the ravines, etc., and certain other land suitable for parks. These may then be connected by proposed parkways. These areas being determined, it is unnecessary to lay them off into streets. The city-plan is simplified to that extent. The major street plan may be laid down on broad lines. Existing grades may be corrected. Slight alterations may serve to give good results. Certain sharp curves may be eased up by curves of longer radii and offsets may be cured by cutting off some corners. The buildings being shown, studies of the cost of widening may be made and where it is necessary to accommodate the present or future traffic, a new building line may be determined and fixed. The map gives a good idea of the kind of improvements situated within the new lines. In the old parts of town the elevations may show a major street to be necessary on a high grade and not far distant a low grade artery may be indispensable. Provision can be made for connections between the two. In outlying territory, similar conditions may prevail. In the absence of a contour map, this could be seen without a close inspection of the ground and even then the exact locations could not be made unless a survey were available.

Efficiency and Economy

The old checker-board street systems are not practicable, efficient, or economic over rolling country. Once upon a time that was the only practice. Closer study with broader information at hand and more intensive efforts at scientific planning, have tended to make a street plan more nearly fit the natural ground. Some cuts and fills can not be avoided but they can be reduced in number and in magnitude by a more rational layout, which is not only less costly by being more readily adaptable to the surface, but after all it is more beautiful. The monotony of the long uninteresting city streets so common in all cities will give way to the gently curving and sometimes winding parklike road. A contour map is the best possible guide for the city planner. It is likewise a guide to those who would develop land for sale as lots. They can see from such a map how best to make a street layout involving the least expenditure for grading and which will give the best street connections. New streets can be made coterminous with those already existing or a good reason for not doing so will usually appear on the map showing contiguous property. Much money can be saved to the city and to the land owners by the use of a good survey and its cost will be returned many times. Indeed grading cost alone on one or two of the existing main highways of some of the large cities has cost more than a topographic map would cost and had it been available, the alinement might have been different, avoiding part of the outlay for grading.

Grade Crossings Avoided

Outside of what we might call the congested part of town and farther toward the outskirts, major streets may be laid out almost a half mile apart and crossings of railroads and deep gullies may be situated at about half mile intervals. These railroad crossings can be readily determined by studies of the topography. It may be found that where the road is in a cut or fill, there is the logical place to cross instead of at grade any old place as they used to do. The writer emphasizes the grade crossing menace and its abolishment by proper study, because it is so prevalent in all towns.

Sewer Design Depends on Topography

No other feature of city building depends more on the topography than the sewers. The twenty million dollars expended on a comprehensive sewerage system for Baltimore was based entirely on the map of 1894. On it the natural drainage could be traced and the storm water sewers followed it. The drainage area could be readily computed and the size of mains determined. Sanitary sewers were designed too from study of the surface as surveyed and by reasonable deductions as to the use to be made of certain kinds of land. Grades too were an important factor. Water mains are more easily located by having a map showing all physical features so the pipes may conform to the hydraulic gradient and the areas they are to serve will have their bearing on the size.

Rapid Transit

For thoro study of a proposed rapid transit system, a topographic map is essential. Elevations of streets, railroads and streams will give a clear conception of what levels the underground system will have to meet. If an elevated structure is necessary the same data are available and where the way may be open cut on the surface, or on fill, safe and properly located crossings will be situated at suitable intervals.

Correct Base Map for Zoning

Since zoning is a part of city planning, inquiry as to the kind of a map on which to base zoning studies is apropos. It seems necessary to have a correct and complete representation of all present conditions. The buildings must be shown in order to draw clearly in detail an existing use map of the city to be zoned. A good base map would show on inspection that the buildings are of frame, brick, stone or steel construction. It will appear that some of the buildings are attached, that is, built in rows without side yards. Others will appear to be of the type known as semi-detached houses built in pairs, joined on one side with one side yard to each unit of the couple. Detached houses with two side yards to each house will be noted. Such a map as has been recommended above will show the buildings which sit back from the front lot line and those that are built up to the street line. The fundamental maps on which zoning studies are based can readily be prepared. It will be easy to give each house a color to denote its use, such as one-family residence, two-family residence, three or more family residence, business, industrial, and nuisance uses. Other sets of fundamental maps can be prepared easily, showing by color the heights of buildings, per cent of area of lot covered by buildings and the assessed land values on a front foot basis.

Necessary Guides in Setecling Zones

Certain other studies preliminary and essential before drawing a tentative zone plan, can be made from the topographic map. The built-up areas are noticeable at a glance. The trend of the outgrowth main highways and the development between them are apparent. Parks and cemeteries, where people do not dwell and therefore, where zoning for residence or business will not be necessary, show on the map. It will show by the contours and physical feature, the lands suitable for future parking; along the streams, ravines cliffs, etc., where the land is not so adaptable to building purposes. Low flat lands along the waterfront and railroads, suitable for industrial sites, for railroad yards, warehouses, piers, docks and shipyards are readily determined. The topography directs attention to the areas suitable for residential development. They can be so designated on the proposed use district maps. Housing areas convenient to industrial districts, to insure ample and satisfied labor supply are necessary. They are chosen with great care and discrimination, with due consideration for the existing developments. The engineer can with understanding, with knowledge of the growth of the city, with information shown by contours, select major traffic streets which will probably become retail business streets or heavy commercial haulage ways. Parkways and boulevards for the highest class residential frontage may be well chosen. All of these aspects of a zone plan are at once before the engineer or city-planner who has an accurate, comprehensive topographic map upon which to work.

Map of Baltimore Ideal

In 1894 the Topographical Survey Commission of Baltimore began the preparation of a topographic map of that city on a scale of 200 feet to the inch, with contours at five foot intervals. The map covered thirty square miles, the City's area at that time. The old part of the city prior to the annex of 1888 had been planned in 1819 without reference to topography. On the new map a plan was drawn and adopted for the development of the territory annexed in 1888. The city is now following that plan. In 1914 another map showing all the buildings in the city was made with the surveyed street plan as the frame work. In 1918 an additional sixty square miles of territory was annexed. Now the topographic map of 1894 is being extended to embrace the new addition and should be complete by 1922. These maps will give ample information on which to extend the street plan, design sewer extensions and water mains and to draw a zone plan, which ought to be the very best obtainable since it will be based on a mass of data not usually available for zoning studies.

Cost and Compensations

Does the cost of making such a map pay? Well, if Baltimore's sewerage system cost $20,000,000, it is conservative to estimate that one per cent of that amount or $200,000 would have been spent for surveys had not the map of 1894 been made. The map was paid for then by saving on one project. Thousands of dollars have been saved to property owners and taxpayers by reason of having a map available for the use of surveyors and engineers. By planning streets with reference to the contour of the ground the expenditure has been paid for many times over. City planning pays and the use of the term "city planning" ought to include the topographic map as the first step toward a comprehensive plan.

REPORT OF THE GENERAL COMMITTEE ON STREET PAVING, SIDEWALKS AND STREET DESIGN, STREET MAINTENANCE AND STREET RAILWAY CONSTRUCTION

William A. Howell, Chairman, Newark, N. J.

In presenting his report as chairman of the above outlined Committee, the writer has about the same feeling of diffidence as had Ben Hur when he first appeared with his mighty four in hand in General Wallace's novel. The writer has endeavored to interfere as little as possible with the functions of the four chairmen of sub-committees. He has endeavored to secure as many papers as possible and he has uniformly agreed with the methods adopted by the various chairmen of sub-committees. The most embarrassing thing in connection with the Committee's work this year is the duplication of committees presumably working along similar lines. For instance, Sub-committee D—Street Railway Construction, whose chairman is Mr. C. A. Poole of Rochester, N. Y., has another committee working on similar lines known as Committee on Specifications for Street Railway Pavements including track construction. This committee is headed by Mr. Charles E. De Leuw of Chicago. As this committee has already had its report printed in the Advance Papers it will simplify the work of our Sub-committee D.

Sub-Committee A—Street Paving

The writer has received reports from the New York City Boros of Manhattan, Brooklyn, Queens and the Bronx; from Chicago, Philadelphia, Boston, Baltimore, Detroit, Cleveland, Cincinnati, Pittsburg, Birmingham, Ala., St. Louis, Portland, Ore., San Francisco, Los Angeles, Syracuse, Rochester, Baltimore, Charleston, S. C., Kansas City, Minneapolis, St. Paul, Memphis, Salt Lake City, Toronto, Canada, and Newark, N. J. These reports require considerable time to prepare with any degree of accuracy, and the writer wishes at this time to thank the city engineers and public works commissioners who have so cheerfully furnished the valuable information requested. The consensus of opinion thruout the entire country is that the need of good roads, of new pavings, and repavings, was never greater, but that on account of the economic condition of the country, public officials are very slow to advance any very ambitious paving programs at this time. There is another angle to this subject that may cause a change of front. While it is true that our people are being taxed to death, that the municipal debts of the various large cities closely approach the danger point, the quickest and safest method of taking care of the army of the unemployed is to start public improvements. A man without a job, no money in the bank and a family to support, is not going to haggle about wages. This question has been widely discussed, and it seems not only likely, but exceedingly probable, that the great State of New York will soon provide work for thousands of the unemployed. What New York will be able to do, the National Government can more readily do. If the various municipalities can at this time thru speedy legislation get State aid on projected public improvements, the number of the unemployed will be very materially reduced. The writer has endeavored with very small success to get data from the various paving material associations as to the volume of business handled during 1921. How the paving-brick output compares with such years as 1913 or 1914 the writer has been unable to ascertain. In the locality of New York City there has been considerable activity in granite, and asphalt, and very little activity in wood block, and asphalt block. The concrete pavement seems to be gaining in favor wherever the automobile is used, but not where used by steel-tired vehicles only. It is very unfortunate that just at the time when the volume and weight of traffic on our public highways had increased by leaps and bounds, particularly the motor-truck traffic, the financial ability of public bodies to keep these roads in good repair has very greatly diminished. The high cost of state and municipal taxation resulting from causes produced by the World War, such as the war bonuses of the various States has taken away funds what otherwise might have been used for public roads.

Sub-Committee B—Sidewalks and Street Design

Chairman Conant in a valued communication mailed to the writer on September 10, 1921, expressed the fear that the work of this sub-committee was very liable to overlap the work of the City-Planning Committee. We will await the pleasure of the Convention in its wisdom to straighten out these and other apparent duplications of the work of standing committees. Mr. Hittell of this Committee has suggested that the study of this Committee should embrace in its scope the following:

1. Utility; 2. Appearance; 3. Safety;
4. Drainage, 5. Provision to meet future needs.

1. Utility would require a consideration of the grades, crowns, and slopes so that the traffic would be least impeded; the elimination of very large openings to sewers, poles in roadways, etc.

2. Appearance. A consideration of the relative position of walks, parks and roadways, lamp posts, hydrants, poles.

3. Safety. A consideration of the safety islands; deep gutters at crossings; large radii at corners, minimizing the probability of harm to pedestrians from uncontrollable traffic, or ordinary traffic when the roadways are covered with mud or slush.

4. Drainage. A consideration of proper facilities for the quick removal of surface water to the sewers; dry crosswalks,

and permanent markers to locate intakes when snow or ice cover the street.

5. Re-arrangement. A consideration of what changes could be made of present design (without acquiring additional land) to meet greatly different conditions of traffic.

It seems to your Chairman that the sub-committee members have given very thoughtful and intelligent consideration to this topic and the writer awaits their conclusions with great interest.

The writer was greatly interested in the following special cable report of the New York Herald. "Paris intends to spend 125,000,000 francs to beautify and modernize its parks and streets before the first of January, 1922. But this is only the beginning, as plans already approved call for the expenditure of more than 10 billion francs of the last loan of 18 billion for various improvements. Naturally each arrondisement is fighting for the lion's share of the improvement funds, as once the work is started, it will provide an easy solution for the city's unemployment problem, and it is even likely that the work will attract thousands from the smaller towns where the industrial crisis is menacing ordinary prosperity. The New York Herald's bureau is informed that work is to be resumed on a large scale to demolish the old fortifications, the sites of which are to be transformed into playgrounds for youngsters, and parks for the older citizens. The area behind Sorbonne University is to be devoted entirely to the construction of a "university city" with a modern hotel for students, and numerous clubs, swimming baths and gymnasiums. This will require several million francs and depends on Government assistance, but the city fathers do not intend to delay other projects which were held up by the war. One of the biggest of these is the remodelling of the majority of the public hospitals, many of which are housed in buildings two centuries old, with the floors rotting away and often verminous, while little space is devoted to laboratories and operating rooms such as are found in any American city. Experts already are drawing up plans for hospital changes as well as planning extensive anti-consumption and anti-venereal campaigns covering every quarter of the capital. Schools, markets and streets also will not be overlooked. In the schools the Council intends to install an American system of inspection of the health of the pupils, while every school is to be supplied with shower baths and modern watered sewer systems. The Prefect of Paris is personally visiting sections of the city which have been allowed to become disgraceful as far as sanitary measures are concerned, and has commenced his campaign for the century-old ordinance against throwing papers, fruit peelings and other objectionable refuse into the streets, with the probability that hundreds of offenders will face punishment for tossing useless autobus refuse to the boulevards. In the public markets the Council intends to increase immediately the use of refrigeration to prevent the waste of hundreds of tons of meats and vegetables weekly owing to the impossibility of keeping them fresh under existing conditions. Proposals which were read at a recent session of the Council's Progress Committee include the eventual extension of Paris far beyond the present boundaries, as the impossibility of obtaining houses and apartments is driving thousands to neighboring suburbs such as Montrouge, Fontenay, Sceaux, Nogent, and St. Maude. In order to develop this tendency it is likely that a part of the 10 billion francs will be set aside to subsidize the construction of homes, influential Senators and Deputies having expressed their willingness to obtain co-operation from the Government to the extent of any sum the Paris Council is willing to contribute. The construction of homes in neighboring suburbs is considered a profitable investment, as once the territory now separating the suburbs from Paris is built up, the limits of the city will be advanced in all directions so as to produce a metropolis estimated to have a population of 5,000,000 which will result in an increase in tax receipts by the City."

Sub-Committee C—Street Maintenance

In announcing at the beginning of the program that it intended to cover the following 8 points, this committee has done well. They are as follows:

A. The relation of original construction to maintenance. What original expenditure plus the cost of maintenance will give a serviceable pavement for a given condition at the minimum cost.

B. The extent of the obligation to be placed upon the construction contract in guarantee or maintenance provisions to obtain the best results at the minimum cost.

C. The extent to which repairs or maintenance may economically be carried before reconstruction or repaving.

D. The economical extent to which repairs may be carried for the purpose of extending the useful life of pavement.

E. The extent to which old materials may be used in maintenance where such would not be suitable for new construction.

F. The details best adapted for the repairs of various kinds of pavements.

G. The extent of records of repairs necessary to be kept to form sound engineering conclusions upon the economic problems here outlined.

The importance of street maintenance has only been realized in this country within a comparatively recent period. In France and Germany, maintenance has been regarded as of equal importance with construction for many years. In this country miles of costly granite, wood block, brick or asphalt streets have been laid and not touched for years, when extensive repairs were made necessary, when if proper maintenance systems had been in force, the various pavements could have been kept in good condition constantly, with a minimum annual cost of repair. Every large American city is alive to the maintenance question to-day, and maintenance repair gangs are in constant service on block and bituminous pavements. In many cities asphalt repair plants have been installed, and have kept in touch with asphalt repairs right up to date, altho usually operated at an increased cost over private plants. In many cities, with enabling legislation it has been found possible for the municipal plant to participate in bidding for new construction, or for resurfacing worn out brick, telford or macadam highways. Even if the cost of asphalt repairs is higher with a municipal plant than by private bidding, there is a healthier aspect about city ownership of a plant and it has a good influence in stimulating competition. The private asphalt companies in a city owning a plant are not tempted to profiteer; and it is a distinct advantage to have paving gangs available, and under perfect control, for work in certain districts where they may be recalled after short intervals, where a private company would not submit to such restrictions, insisting upon maintaining a program of their own. In the city of the writer a small asphalt repair plant costing with building about $12,500 was installed in 1913. The cost of asphalt repairs had steadily mounted for several years previously, and a considerable saving was effected, it being possible with the city plant to go over certain streets 3 or 4 times each year, which had never been possible to attain under private contracts. During the present year a much larger plant with buildings has been installed at a cost of about $67,000 and we anticipate getting ample returns from the money invested in increased efficiency. The trend of paving sentiment in eastern cities during recent years has uniformly been in favor of asphalt or bituminous concrete on residential streets, and even on worn-out brick and concrete streets asphalt is available for resurfacing.

The writer has been deeply interested during the present year, in the repair of an important highway, involving a total yardage of about 80,000 square yards of wood block. The street was paved in 1914, and remained in almost perfect condition for five years. The street, which was a wide one, (92 feet between curbs), had two street-railway tracks in the center, paved in a very thoro manner with granite on concrete in 1909. The heavy traffic on the street-railway tracks had caused the rails to cut into the ties and produced considerable vibration, so that shortly after the wood block pavement was laid in 1914, the blocks in several places broke away from the rails and had to be relaid with cement joints. Water gradually worked under the wood blocks, from the tracks, and caused a disintegration of the mortar cushion, some portions of the pavement in spots having no cushion, and in other places, having two inches under the blocks. Extensive repairs costing about $22,000, representing about 5 per cent of the cost of the pavement, have been made this year, as follows: Where there were depressions, the worn-out cushion was scraped off the old concrete base and a ½ mix of cement, sand, and water, one inch thick, laid on the concrete base and allowed to harden for several days. Hot asphalt having a penetration of about 50 was laid on the new cushion and allowed to cool, the old blocks being laid on the asphalt coat, and hot asphalt and sand poured into the joints. Traffic was turned on the newly repaired pavement within 24 hours after the laying of the blocks, and has met the situation very satisfactorily. During the war the street in question received an abnormally heavy motor-truck traffic. Some of the leading wood-block advocates have informed the writer, that where new wood blocks are laid, they should be laid on a tar-coated base, but old blocks being repaved, and having lost much of their original preservative, should be laid on an asphalt coated base, as was done in the city of the writer, the idea being that the tar products and preservative in the wood block would work in sympathy, and harmony with the tar coating on the concrete base and filler in the blocks.

With public bodies unwilling, or financially unable, to provide funds for new paving projects, the question of paving maintenance assumes great prominence. The Boro of Manhattan at one time had a rule, which may, or may not, still be in effect, that when the total cost of repairs on any particular street amounted to 40 per cent of the original cost, the street would automatically be repaved. In these post-war days when taxes of all kinds are soaring and municipal debts are approaching the legal limit it is not so easy to inaugurate legislation for new paving projects. In the city of the speaker an ambitious paving program was announced at the beginning of the present year involving the proposed expenditure of some two million dollars, nearly one-half of which represented the repaving of miles of worn-out granite streets. Owing to the opposition of property owners, who objected to any assessments whatever, suggesting that the entire cost should be borne by the city at large, and the inability of the city to assume such a burden, the actual amount of paving work completed will represent approximately one-third of the original program. The importance of the maintenance feature is at once apparent. Asphalt and bituminous concrete pavements needing resurfacing are patched up by the municipal plant or by public contract. Another factor adds very much to the importance of street maintenance at present, and that is the building boom, temporarily closed down by the world war. New water, gas and sewer connections are put in streets where the original lay-out of lots was changed after the street was originally paved. In the business district new moving picture theaters, and large apartment buildings require increased pressure of water, etc. necessitating new cuts in the pavement.

Sub-Committee D—Street Railway Construction

The street-railway companies of the United States have had for several years a fight for existence. In most large cities that the writer is familiar with, maintenance has been greatly curtailed. Where traffic conditions have made it imperatively necessary to repave important highways, the street railway company has held up the improvement indefinitely by its inability to finance the street railway part of the improvement. And that brings up the question that is suggested by Mr. Hempelmann, engineer of The Texas Co., in the report of the Committee on Specifications for Street Railway Pavements including track construction. Mr. Hempelmann recommends the inclusion of a header course immediately outside of the railway ties. The inclusion of a header course definitely restricts the damage done to the pavement because of any disturbance brought about thru the street car traffic and particularly insures construction conditions similar to those involved in paving a narrow curbed roadway. As stated by Mr. Hempelmann, such construction permits the complete improvement of the pavement areas from the curb to the header course without interference with the street-railway right-of-way section. The writer has noted this type of construction in a number of Southern cities, but from various reasons it has not been adopted in any considerable city in the North within the observation of the writer. In the good old days before the world war, the street-railway companies in most large cities gladly co-operated and kept pace with the municipality in keeping track construction and paving on a par with the main roadway pavements. The city that has had that kind of co-operation during the last 5 or 6 years is fortunate indeed. In many cities expensive granite and other pavements are being laid outside of tracks with worn-out road-beds, defective drainage and worn-out track pavements. The type of construction described by Mr. MacGregor, quoted in the Report of the Committee on Specifications for Street-Railway Pavements including track construction, as being in use in the Boro of Manhattan is common to many large cities on the Eastern Seaboard. Another interesting feature of today is the recent trial in a number of cities of the trackless trolley. The writer saw the operation of this bus on the films. In Detroit as stated in the New York Herald, the trial trip occurred on August 23 last. The trackless-trolley bus runs by electricity on rubber wheels and carries 30 passengers. It can be double-decked and pulls a trailer. In the Detroit trial the car attained a speed of 30 miles per hour. The Packard Motor Co. and the Westinghouse Electric and Manufacturing Co. having co-operated in creating a working model, demonstrating the use to which the trackless trolley may be put. Long trolley poles give to the vehicle a wide range in the street, and it can swing to right and left to pass other traffic. The bus is 24 feet long, 8 feet wide and weighs 11,500 pounds, compared with 16,000 pounds, the weight of the municipal street car in Detroit. Street-railway officials in conversation with the writer did not seem to be favorably impressed with the operation of the bus. One official stated that the bus absolutely would not do at all in the business section in congested traffic. He admitted that in residential districts or in the suburbs it would probably be successful and would permit the taking up of many miles of street-railway tracks, and the saving of the cost of much street-railway pavement to the companies. There have been demonstrations of the trackless trolley in Staten Island and Richmond, Va.

DISCUSSION

Secretary Brown (by letter): The seeming duplication of committees in the same field mentioned by Mr. Howell, Mr. Poole, and Mr. Conant, is caused by mis-reading of the titles of the committees.

The sub-committee on Street-Railway Construction and the committee on Specifications for Street-Railway Pavements including Track Construction would ordinarily be as independent of each other as the General Committee of which Mr. Howell is chairman is independent of the various committees on specifications for Sheet Asphalt, Brick and other pavements.

They are both new committees and it was necessary for Mr. DeLeuw's committee to gather data on which to base their proposed specifications. They have very properly thought best to present these data with their report of proposed specifications. Probably this will not occur again and this sort of work will belong to sub-committee D of the general committee on Street Paving, etc.

There would doubtless have been closer co-operation between the two committees if they had not been so new, and therefore so little known to each other.

The sub-committee of which Mr. Conant is chairman would seem to have as its field the detailed work, the City-Planning Committee devoting itself to the relations of street and sidewalk design to the city plan. These two committees should co-operate also.

REPORT OF SUB-COMMITTEE A ON STREET PAVING

K. C. Kastberg, Chairman, Des Moines, Iowa

The work of the Sub-committee on Street Paving has of necessity been very limited. The chairman has in the short time available, and from the fact that there has been a very slow response to the questionnaires submitted, been unable to prepare a report which he would feel to be commensurate with the topic assigned.

The subject of pavements is at this time of paramount importance, in view of the tremendous development of street and highway improvements thruout the country.

The advent of the motor-propelled vehicle both for passenger and freight traffic has accentuated the necessity for an all-year roadway, and due to the change in type of wheels and equipment and the greater speed of locomotion, a more substantial and smoother surface becomes an essential feature of street pavement.

These factors all tend to develop and attract attention to the structural features of pavements.

Engineers are confronted with entirely different problems today than those which engaged their attention a decade ago. To analyze in detail the constituent features of paving construction, maintenance, and costs, would involve us to a degree far beyond the province of the committee, hence we feel, that in order to achieve definite results, some plan of study should be inaugurated, which would become progressive in its character and would guide and instruct this committee and its successors in the work which it would gladly undertake for the advancement of this branch of the Society's activities for the advancement of public improvements.

We would suggest that the work of the committee be outlined so that its efforts would co-ordinate and develop along with those of the other committees whose fields approximate a similar line of investigation.

A suggestion along this line would be the preparation of a general questionnaire, which would be of such character as would enable the correspondent to indicate by affirmative or negative response as to the features observed, supplemented by remarks applicable.

The questions which appear momentarily of importance have to do particularly with the different types of structures extant; observation of the behavior of the several types of pavements under the changing traffic conditions extending back over a period of approximately twenty years; essential features of their construction and the amount and character of the traffic carried. This leads up to the development of a standard type of report for traffic observation; chronological data as to changes in traffic and observed behavior of the structure, and the original costs and maintenance expenditures.

Records and data upon the results of changes made from time to time in attempting to alleviate difficulties which developed, in order that a comparison might be made which would later indicate the advisability or inadvisability of attempting the same or similar ventures. As no community can within itself develop all of the difficulties or defects nor provide the cure-all for those which have developed, it becomes our province to assemble and compare the efforts and results which have been secured thruout the larger field covered by a numerous body of observers.

With this in mind, the committee would welcome suggestions and inquiries tending to bring out the salient features involved and would then be in position to submit such inquiries in form to develop responses supported by the experience of the entire field covered.

The data collected upon progress of paving work accomplished have not been sufficient to make a comprehensive report. However we are submitting a general report which covers the State of Iowa, and a statistical record of data furnished by the various cities represented in the following pages.

Pavement Contracts Awarded in the State of Iowa From January 1, 1921 to September 20, 1921

Concrete Pavements:

Streets 442,901 sq. yd.; alleys 45,397 sq. yd.; roads 321,156 sq. yd.; Total 809,454 sq. yd.

TYPE	PRICE			
1-course reinforced, 8″	$3.48;	$3.68;	$3.79;	$4.96
1-course reinforced, 7″	3.40;	4.18;	5.49	
1-course reinforced, 6″	2.97;	3.47;	3.58	
1-course plain, 7″	2.35;	3.35;	3.45;	3.50
1-course plain, 6″	2.18;	2.48;	3.15;	3.38
2-course reinforced, 8″	3.55			
2-course reinforced, 7″	3.76			
2-course plain, 7″	2.50;	2.84;		

The concrete yardage represents 74% of the total municipal contracts for new pavements and 60% of all pavements laid, including new and resurfaced yardage. There are no concrete resurfaced projects in the state.

Asphaltic Concrete Pavements:
Total yardage 38,318 sq. yd.; 2-inch wearing surface on 5-inch concrete base $3.20 to $3.49 per sq. yd. On 6-inch base, $3.68 per sq. yd.

Brick Pavements:
Total yardage 78,609 sq. yd.; on 4-inch concrete base $4.07 per sq. yd.; on 5-inch concrete base $3.98, $4.19, $4.43, $4.70, $5.25 per sq. yd.; on 6-inch concerete base $4.21 to $5.75 per sq. yd.

Sheet Asphalt Pavement:
Total yardage 38,609 sq. yd.; 1½-inch top, 1-inch binder on 5-inch concrete base $3.72 to $4.58 per sq. yd.; on 6-inch concrete base $3.80 to $4.49 per sq. yd.

Bitulithic Pavements:
Total yardage 133,837 sq. yd.; 2-inch wearing surface on 5-inch concrete base $3.38 to $4.49 per sq. yd.

Willite Pavements:
Total yardage 22,568 sq. yd.; on 5-inch base $3.30 to $3.94 per sq. yd.

Resurfacing:
Brick 16,945 sq. yd.; $1.80 to $2.35 per sq. yd.
Bitulithic 64,270 sq. yd.; $2.34; 2.40; $2.45; $3.34 per sq. yd.
Sheet Asphalt 34,570 sq. yd.; $2.15 to $4.29 per sq. yd.
Asphaltic Concrete 7,157 sq. yd.; $1.80 to $2.35 per sq. yd.
Willite 12,433 sq. yd.; $2.03; $2.10; $2.40.
Total yardage of resurface work—135,375 sq. yd.

Macadam:
Total yardage 99,735 sq. yd.; $1.29.

A resumé of the paving situation indicates a progressive program of improvement when the reconstruction period is considered. A comparison of the municipal and state road contracts is indicative of conditions.

	Municipal Contracts	*State Road Contracts*
Yardage carried over to 1921	779,933	1,538,524
Yardage awarded in 1921	474,694	337,598
Yardage completed in 1921	918,896	1,499,386
Uncompleted yardage	335,731	176,336

Number of cities reporting on pavement improvements, 39.
Number of counties' road paving programs under Federal aid, 19.

Counties not having road paving projects have elected to avail themselves of the provisions of the Federal aid laws, which enable them to engage in a program of road graveling, and are engaged extensively in this class of work. Data are not available at the present time as to the extent thereof.

New York City,

Queens Boro

PAVING WORK DONE DURING 1921

Contracts	*Kind of Improvement*	*Square Yards*	*Average Cost Per Sq. Yd., Including Foundation*
7	Sheet asphalt	35,930	$4.02
3	Asphalt block	23,100	5.53
4	Granite	13,540	8.19
1	Bituminous concrete	17,000	4.50

J. J. Beaver,
Engineer of Highways.

Boro of Manhattan

CONTRACTS AWARDED

Granite block	148,000 sq. yd.	$1,408,000
Asphalt	93,000 sq. yd.	628,000

R. A. Mac Gregor,
Division Engineer

Boro of Bronx

CONTRACTS AWARDED

Granite block pavement, all kinds	78,300 sq. yd.
Sheet asphalt	71,700 " "
Asphalt block	4,800 " "
Bituminous concrete (Topeka)	5,360 " "

Total estimated cost of all the above contracts amounts to $1,088,600.

Josiah H. Fitch,
Chief Engineer.

Boro of Brooklyn

1. Approximate yardage of paving laid at the expense of property owners....210,000 sq. yd.
2. Approximate yardage of pavement laid at the expense of the city....430,000 sq. yd.
3. Value of sidewalk, curb, etc....$300,000
4. Estimate of total amount of work to be performed during 1921....$3,250,000

Asphalt	$2.55
Granite	6.00
Concrete	9.50 per cu. yd.
Cement walk, steel-bound cement sidewalk	.30 per sq. ft.

Recent prices in some of the above items are as follows:

Asphalt	$2.25
Concrete	8.50 per cu. yd.
Cement curb	1.05
Cement side-walk	.27 per sq. ft.

Courtesy of J. C. Clinton,
Acting Chief Engineer.

Birmingham, Alabama

PAVING ACTIVITIES DURING 1921

	Sq. Yd.	*Estimated Cost*	*Estimated Cost of Other Items*	*Total Cost*
Sheet asphalt.......	59,096	$201,962.00	$43,516.00	
To be let...........	51,366	125,728.00	73,719.00	
	110,464	$327,690.00	$117,235.00	$444,925.00
Asphaltic concrete...	123,735	$315,500.00	$94,075.00	
To be let...........	16,340	36,915.00	10,644.00	
	140,075	$352,415.00	$104,719.00	$457,134.00
Bitulithic...........	28,674	$74,225.00	$19,702.00	$93,927.00
Concrete...........	15,959	32,912.00	15,580.00	48,492.00
				$1,044,478.00

The price for paving includes the necessary excavation where the same does not exceed twelve inches. In the column of cost headed "Estimated Cost of Other Items" is included the cost of extra excavation, curbing, gutter paving and sidewalk paving, each of which items varies according to the amount of work previously done on the street. The indications are that contract will be let for even a greater yardage than indicated above before the close of the year.

JULIAN KENDRICK,
City Engineer.

Pittsburg, Pennsylvania

The Director of Public Works has stated that on September 1 more than $6,000,000 worth of municipal improvements were under way, and bids for an additional million dollars' worth are now being advertised. The work consists of street improvement and play-ground and sewer construction for the most part. The largest item is $300,000 for improving Brownsville Ave. The Hazlewood sewer system will cost $80,000. Two viaducts on the Boulevard of the Allies are other large pieces of work included in the total.

San Francisco, California

Cost of street work constructed under supervision of the city engineer..	$881,882.27
Cost of street work constructed under street repair department, for which working plans were prepared by the city engineer.	283,586.00
Total..	$1,165,468.27

Area of pavement constructed under direct supervision of city engineer	1,877,373 sq. ft.
Area of pavement constructed by street repair department for which working plans were prepared by city engineer	699,819 sq. ft.
Total	2,577,192 sq. ft.

Of the $881,882.27 above mentioned, the sum of $515,689.20 was expended for pavements only, classified as follows:

Sheet asphalt and asphaltic concrete pavement on 6-inch concrete base	1,705,752 sq. ft.	$452,448.99
Brick pavement on 6-inch concrete base	25,920 " "	14,680.92
6-inch concrete pavement	145,701 " "	48,559.29
Total cost		$515,689.20

M. M. O'Shaughnessy,
City Engineer.

Detroit, Michigan

664,000 sq. yd. of sheet asphalt paving has been contracted for at a total cost of $4,200,000. This is for 3½-inch asphalt on 8-inch concrete base, and is the only kind of pavement that is being laid in Detroit this year.

Joseph A. Martin, Commissioner.

Boston, Massachusetts

ESTIMATED YARDAGE FOR 1921

Asphalt	190,000 sq. yd.
New granite	25,000 " "
Wood block	10,000 " "
Relaid granite blocks	75,000 " "

Joshua Atwood,
Engineer in Charge.

Syracuse, New York

We have let during 1921 and up to August 1, 38 separate contracts for paving, resurfacing and repaving, aggregating at the letting price $707,566. To this should be added about two per cent for inspection and extras for the present estimated cost.

The above contracts aggregate approximately in mileage as follows:

Pavements	2.4 miles
Resurface and repavements	5.2 miles

Henry C. Allen, City Engineer,
William A. Gere, Deputy City Engineer.

Charleston, South Carolina

We have not contracted for any paving during 1921. We are now calling for bids for 110,000 sq. yd. sheet asphalt.

J. H. Dingle, City Engineer.

Philadelphia, Pennsylvania

It is not possible to give an exact statement of the amount of street paving and repaving within the city limits done during 1921. However, this bureau has had an appropriation of $6,000-000 for repaving streets, and the placing of this sum under contract will be completed within a few weeks. On original paving work we will be advertising from time to time until the end of the year, and the total value of this work, will, no doubt, aggregate about $1,000,000. At an average price of $4.50 per square yard, which includes paving and incidental work, the above figures would amount to about 1,500,000 square yards of new paving and repaving, or in the neighborhood of 95 miles will have been laid.

JULIUS ADLER, Deputy Chief of Highways.

Cleveland, Ohio

In general, our paving program has been considerably interfered with, partly by reason of financial conditions, and partly by reason of prices bid being higher than the estimates of cost of the work as prepared a few years ago, and upon which the paving assessments were based. We have, however, so far, entered into contract for paving forty-five (45) streets, which will involve a total expenditure of about $1,362,000. It is contemplated that a few more contracts will be entered into which may involve an additional expenditure of $250,000. In addition to this, the city and county jointly have arranged for the paving of one street, work upon which has just been begun, and which will involve an expenditure of about $425,682, providing for the repavement of 10,500 linear feet of block-stone paving.

The work contemplated under the forty-five contracts above mentioned provides for the construction of the following amounts:

Brick	122,435 sq. yd.
Granite block	22,033 " "
Asphaltic concrete	14,362 " "
Sheet asphalt, including resurf	29,135 " "
Medina sandstone	133 " "

Robert Hoffman,
City Engineer.

Chicago, Illinois

The indications are that the paving yardage as awarded for Chicago this year will be very small as compared with pre-war years. This is due in a great measure to the waiting policy of the public. It is not unusual at public hearings to have property owners make statements as follows: "We do not object to having our street paved, but we do not want the paving at this time; we prefer to wait until prices come down." Tho the total yardage awarded this year is comparatively small, nevertheless, the percentage of sheet-asphalt pavements is high. This is due to the fact that the Board of Local Improvements believes that sheet-asphalt is the most serviceable and economic type of pavement that can be laid in a city like Chicago. The city of Chicago, up to date, during the present year, has awarded contracts to the amount of 554,450 sq. yd. The total contract cost of the work, including curbing and all other incidentals, is $3,393,895.00.

JULIUS G. GABELMAN, Chief Street Engineer.

Atlantic City, N. J.

This city has not contracted for any new paving work during 1921. Some pavements have been laid this spring, but under contracts made in 1920.

JOHN W. HACKNEY, City Engineer.

Kansas City, Missouri

The following are the yards and cost of pavement awarded up to August 1, 1921; some of these are resurfacing jobs, but the larger amount are new pavement.

Asphalt	59,577 sq. yd	$251,865.16
Brick	65,178 " "	362,838.97
Concrete	48,562 " "	165,839.39
Macadam	5,826 " "	11,371.20

We expect to lay during the season of 1921, 246,484 sq. yds. of permanent paving, comprising a distance of 15.75 miles, at an estimated cost of $988,000.

ROBERT W. WADDELL, City Engineer.

Memphis Tennessee

On August 2, 1921 this department awarded a contract for the amount of approximately $140,000. This was approximately 30,000 sq. yd. of sheet-asphalt pavement with concrete foundation, together with the necessary grading, drainage and curbing. Within the next 60 days we expect to award contracts for approximately $175,000. This will comprise approximately 50,000 yards of sheet-asphalt paving.

We have completed during the first eight months of this year about $225,000 worth of paving, the contracts having been awarded during the latter part of the year 1920. This work consisted of approximately 60,000 sq. yds. of sheet-asphalt pavement with concrete foundation.

We have an extensive program outlined for street work for the next two years that will approximate $1,500,000. The bulk of this work will be sheet-asphalt paving, and will include the widening and extending of the streets in the business section of the city to accommodate the ever increasing traffic.

WILLIAM B. FOWLER, City Engineer.

Minneapolis, Minnesota

As you will remember, the city of Minneapolis does its own work by day labor. We therefore have no contracts, so in reply to your inquiry of August 1, I beg to state that we have completed this season to August 1, 114,843 sq. yd. of paving at a cost of $514,978, and we are now constructing 63,408 sq. yd. at a cost of $305,172.00, and are waiting for money which will permit us to lay additonal 82,009 sq. yd. which will cost $365,097.00. The total season's work will therefore be 260,260 sq. yd., at a cost of $1,185,247.00. The distribution of these totals will be as follows:

Creosoted wood block	94,574 sq. yd	$508,519.00
Asphaltic concrete	81,861 " "	311,579.00
Brick	27,216 " "	139,048.00
Granite	23,620 " "	118,100.00
Concrete	32,989 " "	108,001.00
	260,260 " "	$1,185,247.00

Frederick W. Cappelen,
City Engineer.

Salt Lake City, Utah

During the present year contracts have been let for 21,100 sq. yd. of hard surface pavement, at a cost of approximately $98,400.

SYLVESTER W. CANNON, City Engineer.

Toronto, Canada

Statement of contracts awarded up to July 25, 1921:

Class of Pavement	*Tendered Prices*	*Area of Pavement Only*
Asphalt	$567,386.00	101,769 sq. yd.
Asphaltic concrete	80,051.00	15,956 " "
Bitulithic	386,889.00	60,523 " "
Brick block	7,579.00	1,097 " "
Concrete	16,675.00	559½ " "
Tarvia surface	5,443.00	5,443 " "

R. C. Harris,
Commissioner of Public Works.

Portland, Oregon

Class of Pavement	*No. of Contracts*	*Lin. Ft.*	*Sq. Yd.*	*Estimated Cost*
Asphalt	7	16,393	70,185	$237,643.85
Bitulithic	11	22,820	87,695	345,585.20
Bituminous macadam	3	6,450	23,010	49,456.75
Brick	7	7,512	24,796	160,812.10
Concrete	3	3,260	11,565	59,254.30
Granite blocks	1	1,310	5,640	50,285.10
Wood block	3	4,730	5,735	55,068.75
Grading	1	2,232	8,570	5,522.55
Brick alleys	16	5,459	11,320	52,815.80
Concrete alleys	63	16,627	28,780	84,993.14
		86,783	277,296	1,101,437.54

G. Laurgaard,
City Engineer.

Newark, N. J.

CONTRACTS COMPLETED OR TO BE COMPLETED IN 1921

Pavement	*Length (Lin. Ft.)*	*Sq. Yd.*	*Cost of Pavement*	*Cost of Accessories*	*Total Cost*
Asphalt resurfacing on old concrete	554	2,410	$6,929.67	$415.85	$7,345.52
Asphalt resurfacing on old telford	4,108	14,772	41,884.21	3,592.35	45,476.56
Asphalt on new concrete	7,025	26,546	109,174.74	14,661.93	123,836.67
Bitulithic flush coat on bitulithic	1,423	5,530	2,323.50	375.00	2,698.50
Bitulithic on new concrete	6,723	37,991	90,964.67	12,281.85	103,246.52
Brick	....	144	1,008.00	552.60	1,560.60
Concrete	6,179	24,691	89,296.31	30,528.03	119,824.34
Napped granite on concrete	8,831	33,895	109,650.72	102,039.50	211,690.22
Napped trap on concrete	1,374	6,375	32,681.74	8,449.08	41,130.82
Grading, curbing and flagging	....	....	....	....	4,365.83
Passaic street retaining wall	....	....	....	....	49,507.20
Commercial street bridge (new steel structure)	....	....	....	....	6,742.45
New asphalt plant buildings and machinery	....	....	....	....	66,254.89
	36,217 6.86 miles	152,354	$483,913.56	$172,896.19	$783,680.12

CONTRACTS AWARDED—NO ESTIMATES PAID

Pavement	*Length*	*Sq. Yd.*	*Amount of Contract*	
Asphalt on new concrete	6325 ft.	25,950	$103,664.10	
Asphalt on old telford	1300 ft.	4,200	11,250.00	
Concrete pavement	1075 ft.	3,500	11,213.50	126,127.60
				$909,807.72

CONTRACTS PARTLY COMPLETED

Pavement	*Length*	*Yards*	*Amount Paid*	*Total Amount of Contract*
Asphalt	550 ft.	1700	$2,252.00	$9,698.50
Asphalt	1040 ft.	3300	3,620.00	16,626.35
Reclipped trap	700 ft.	2400	1,527.40	11,271.50
	2290 ft.	7400	$7,399.40	$37,596.35
Grading, curbing and flagging			8,363.00	12,078.75
			$15,762.40	$49,675.10
Previously listed				909,807.72
Grand total for Newark, N. J. for 1921				$959,482.82

Baltimore, Md.

NEW PAVING, 1921. BY THE PAVING COMMISSION—
R. Keith Compton, Consulting Engineer

Type of Paving	*Contracted Sq. Yd.*	*Completed*	*Aver. Price*
Sheet asphalt paving—1½ wear surf, 1½ in. binder 6-inch concrete base	281,700	202,400	$3.34
Vitrified block, 6 in. base, gutters, alley, ret. etc.	8,800	4,400	$5.68
Red. G. B. 6 in. Base, cement, asphalt filler	35,200	31,680	$5.34
Concrete, 6 in	26,400	8,448	$2.18

REPAVING, 1921. BY THE HIGHWAYS ENGINEER DEPARTMENT
Henry G. Perring, Chief Engineer

	Sq. Yd.	*Aver. Cost Sq. Yd.*
Sheet asphalt 1 in. wearing surf—1 in. binder	4007	$2.07
Sheet asphalt 1½ in. wearing surf—1½ in. binder	5380	$2.16
Sheet asphalt 1½ in. wearing surf—1½ in. binder and 6 in concrete base	2034	$3.12
Sheet asphalt—1½ in. wearing surf. 1½ in. binder, 6 in. concrete base and grading, including removal of old paving	1379	$4.38

ALLEYS PAVED 1921

Yardage Contracted For	*Average Unit Price*	*Yardage Uncompleted*
104,537	$2.05	17,500

REPORT OF SUB-COMMITTEE C ON STREET MAINTENANCE

George H. Norton, Chairman, Buffalo, N. Y.

Your Committee, in taking up this comparatively new field of this Society's activities, can but outline some of the factors involved and endeavor to lay a foundation for future constructive action. This attitude seems warranted from past experiences of various committees whose finished product has been the work of several years, each bringing out at the annual meeting the combined wisdom of those of experience until a broad foundation of fact is laid and sound conclusions are reached.

While no attempt has been made to present definite figures it is most probable that from one-third to one-half as much money is expended in pavement maintenance as in its original construction, yet we have attempted no standardization of the former.

For the purpose of having before us some definite line of action your committee offers the following outline for consideration and developments:

A. The relation of original construction to maintenance. What original expenditure plus cost of maintenance will give a serviceable pavement for a given condition at the minimum cost?

B. The extent of the obligation to be placed upon the construction contract in guarantee or maintenance provisions to obtain the best results at the minimum cost.

C. The extent to which repairs or maintenance may economically be carried before reconstructing or repaving.

D. The economical extent to which repairs may be carried for the purpose of extending the useful life of the pavement.

E. The extent to which old materials may be used in maintenance where such would not be suitable for new construction.

F. The details best adapted for the repairs of various kinds of pavements.

G. The extent of records of repairs necessary to be kept to form sound engineering conclusions upon the economic problems here outlined.

Your committee presents this outline for criticism and suggestions at the convention. After such it believes that the succeeding committee members should present the views of members in the form of papers upon these various phases and then from such and the resulting discussions a general foundation can be laid to establish economic standards for this important part of municipal work.

Your committee believes that the sub-division "A," relation of construction to maintenance costs, has been roughly in the minds of all engaged in paving work, but no reasonable solution, based on facts, seems possible until the points "C" and "D" relative to the proper extent of repairs are definitely standardized.

The obligation desirable to be placed in a construction contract for guarantee or maintenance was given much consideration by the Society for Standardizing Paving Specifications, which society has been merged with this. The general conclusions were that such obligations should be as limited as possible consistent with obtaining satisfactory work. We have made material advance since such time in our knowledge of materials and methods and our standards of construction, which tend to a lessened obligation under construction contracts. However, advance is not made in paving methods and materials without occasionally going into new fields, and where material innovations are proposed the burden of proof of economy and endurance must be largely placed upon those who expect to obtain financial gain, rather than upon the general paying public who should rely on their engineer's judgment, but often are impressed by the salesmanship necessary to promotion along newer lines.

Upon several of these points your committee expects to have papers presented at this meeting which may form the basis for discussion and thereafter of committee recommendation.

It seems desirable to present the matter in this form rather than as Committee recommendations at this time.

RESULTS OBTAINED FROM AN EXPERIMENTAL TREATED WOOD-BLOCK PAVEMENT AFTER FIFTEEN YEARS SERVICE

By J. D. MacLean, Engineer in Forest Products, Forest Products Laboratory, Madison, Wis.

In 1906 an experimental treated wood-block pavement was laid by the city of Minneapolis in co-operation with the Forest Service.[1] This experiment was undertaken to study the following variables:

1. The relative merits of different species of wood for paving block material.
2. The effect of the length of blocks on the wearing qualities of the pavement.
3. The influence of heartwood and sapwood on durability.
4. The relative wear on blocks laid at different angles.

A detailed description of the material used, method of treatment, and construction of the pavement is given in Forest Service Circular 141, "Wood Paving in the United States," by C. L. Hill, issued March 4, 1908; and in Forest Service Circular 194, "Progress Report on Wood-Paving Experiments in Minneapolis," by F. M. Bond, issued January 16, 1912.

Other published information relating to the work is as follows:

"Experiments With Wood Paving Blocks," by C. H. Teesdale; *Municipal Journal* of May 6, 1915.

"Progress Report on Wood-Block Paving Experiments in Minneapolis," by C. H. Teesdale and J. D. MacLean; Proceedings of American Wood Preservers' Association, 1919.

Description of the Pavement

The arrangement and length of the sections originally laid are shown in figure 1. Sections containing Douglas fir, hemlock, longleaf pine, Norway pine, tamarack, western larch, and white birch, were laid on Nicollet Avenue between Washington Avenue and Second Street. This portion of the street is subjected to continuous heavy traffic and the different species were placed in this location to study the relative value of each wood for pavement material.

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[1] Special acknowledgment for assistance in the experiment is due to the City Engineering Department of the city of Minneapolis and the following companies cooperating in the work; The Republic Creosoting Company and the Kettle River Creosoting Company of Minneapolis, the John Week Lumber Company of Stevens Point, Wisconsin, The Cloquet Lumber Company of Cloquet, Minnesota, The Larson Lumber Company, Bellingham, Washington, and The Westside Lumber and Shingle Company, Portland, Oregon.

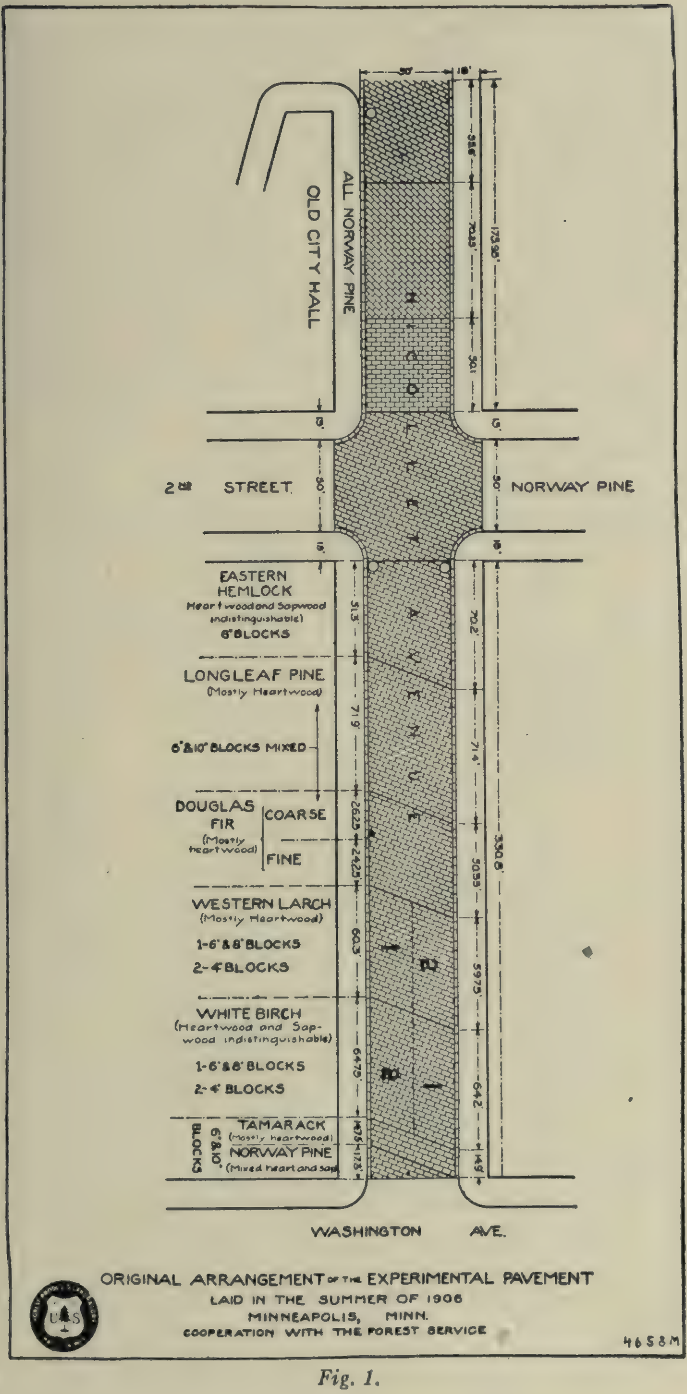
50'
10'
OLD CITY HALL
ALL NORWAY PINE
38.6'
70.25'
173.90'
30.1'
15'
2nd STREET
30'
NORWAY PINE
NICOLLET AVENUE
EASTERN HEMLOCK
Heartwood and Sapwood indistinguishable)
6" BLOCKS
51.3'
70.2'
LONGLEAF PINE
(Mostly Heartwood)
6" & 10" BLOCKS MIXED
71.9'
71.4'
DOUGLAS FIR
(Mostly heartwood)
COARSE
FINE
26.25'
24.25'
50.35'
330.8'
WESTERN LARCH
(Mostly Heartwood)
1-6" & 8" BLOCKS
2-4" BLOCKS
60.3'
59.75'
1
2
WHITE BIRCH
(Heartwood and Sapwood indistinguishable)
1-6" & 8" BLOCKS
2-4" BLOCKS
64.75'
64.2'
TAMARACK
(Mostly heartwood)
NORWAY PINE
(Mixed heart and sap
6" & 10" BLOCKS
14.75'
17.8'
14.9'
WASHINGTON AVE.
ORIGINAL ARRANGEMENT OF THE EXPERIMENTAL PAVEMENT
LAID IN THE SUMMER OF 1906
MINNEAPOLIS, MINN.
COOPERATION WITH THE FOREST SERVICE
4658M

Fig. 1.

In addition to the sections laid with the different species, three sections of Norway pine blocks were laid on Nicollet Avenue, north of the intersection of Second Street. These sections were laid at angles of 90 degrees, 45 degrees, and 67½ degrees with the curb for a comparison of wear on blocks laid at different angles. The blocks in the sections containing the different species were all laid at an angle of 67½ degrees with the curb.

All blocks in the experimental pavement were 4 inches deep and 4 inches wide. The lengths of the blocks of the different species were as follows:

Longleaf pine,	variable	6 inches to 10 inches
Norway pine,	"	6 " to 10 "
Tamarack,	"	6 " to 10 "
Douglas fir,	"	6 " to 10 "
Hemlock		6 "
Western larch	(one half of section)	6 inches and 8 inches
" "	(one half of section)	4 "
White birch	(one half of section)	6 inches and 8 inches
" "	(one half of section)	4 "

Figure 2 shows a top and cross-section view of the pavement construction. The blocks were placed on a one-inch sand cushion over a five-inch cement foundation. One-inch expansion joints were provided at each curb and partially filled with sand. The body joints and the top of the expansion joints were filled with a pitch filler after which a sand dressing was placed over the finished pavement.

Traffic Conditions

Altho the street is fifty feet wide, parking of automobiles along the curb causes the traffic to be concentrated along the central part of the pavement so that about one-half the total width of the street receives most of the wear. This is particularly true of that portion of the pavement between Washington Avenue and Second Street, where the sections containing the different species are located. The three sections of Norway pine north of the intersection of Second Street, which have blocks laid at different angles, do not appear to be under such severe wear as those in the other sections. This is probably because traffic is distributed over a greater width of the pavement, on account of fewer automobiles being parked in this area, and on account of the shorter distance between intersecting streets.

The following traffic census[2] taken from 7:00 A.M. to 7:00 P.M. on June 27, 1921, gives an indication of the amount of traffic passing over the experimental sections which contain the different species.

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[2] **Data furnished by Mr. Ellis R. Dutton, Assistant City Engineer.**

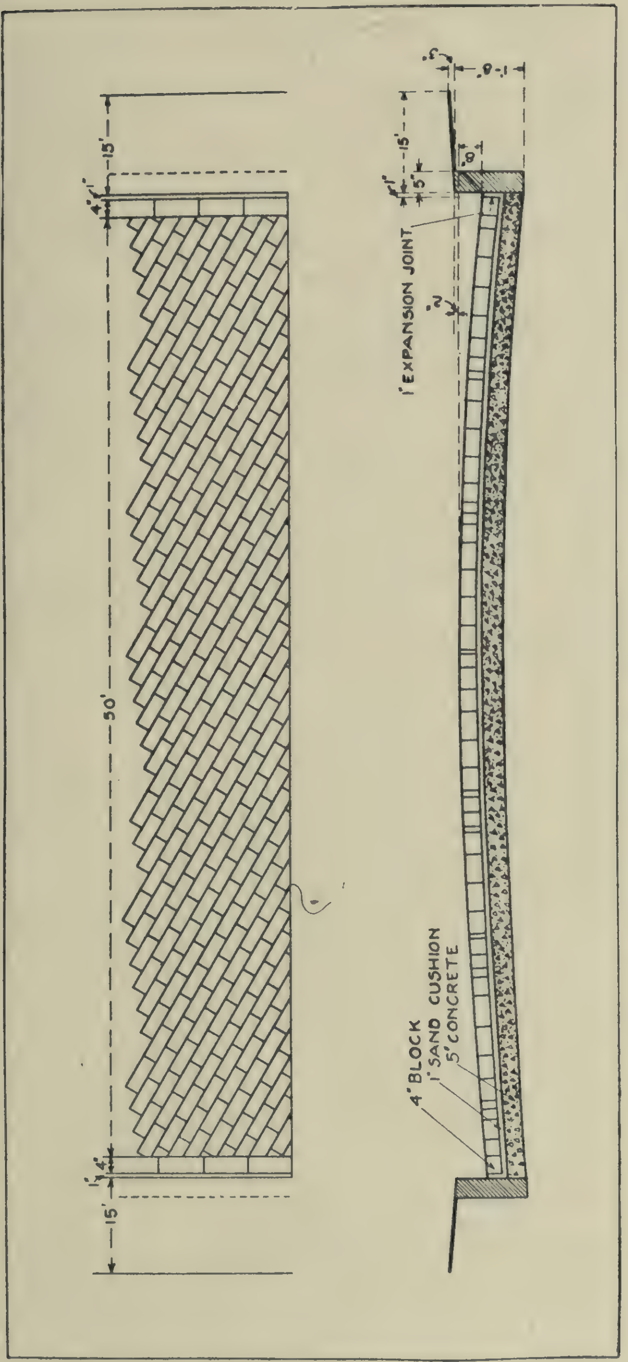

Fig. 2. Details of the Construction of the Experimnetal Pavement

Kind of Vehicle	*Number*
Steel tires	165
Bicycles and motorcycles	142
Automobiles	3501
Trucks	717
Total	4525

Inspections

Annual inspections have been made since the wear developed sufficiently to show progress of deterioration. On account of the pockets and depressions of different sizes and shapes that develop as the time of service increases, a very satisfactory measurement of the wear cannot be made. However, in order to make a comparative estimate of the relative wear on the different sections, the following method was adopted:

1. An estimate of the total number of square feet in a section below the general level of the street was made.

2. An estimate was made of the total number of square feet in a section, ½ inch or more below the general level of the street.

3. Measurements were made on individual blocks to determine the average wear.

The estimates of the area of depressions below the general level of the surface were made independently by each member of the inspection party, after which the estimates were averaged and recorded. When depressions are not extensive such estimates can be made with a fair degree of accuracy, but as the depressions become more numerous greater difficulty is experienced and wider variations are to be expected. While it is difficult to make close estimates of the area affected by depressions, particularly as these areas increase to considerable proportions, the average estimates, however, furnish a means of determining the relative conditions of the different sections. Table 1 gives data on the average results of these inspections.

In order to correct as much as possible for variations in estimates made in different years, the data were plotted and average curves drawn as shown in figure 3.

The measurements of wear were made on blocks taken from the central part of the street where the surface was thought to be fairly representative of the wear in the section.

Results

All of the species originally placed in the pavement are still in service except the Douglas fir blocks which were removed in 1911. It was necessary to re-lay the section containing this species after five years service, as some of the blocks were broken and deep depressions had formed over a large area of the section.

Table 1. - Amount of depression below general level of section.

Section No.	Species	Total area of local depressions below general level of section in percentage of total area of section.											Area of local depressions one-half inch or more below general level of section in percentage of total area of section										
		1910	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1910	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921
1	Norway pine	2.0	2.0	4.5	21.5	16.0	22.5	31.1	34.0	33.3	29.0	37.0	0.0	1.5	2.0	6.5	5.5	13.5	15.9	18.0	20.0	23.0	22.7
2	Tamarack	1.0	2.5	5.5	6.5	7.0	11.0	10.8	22.0	9.2	8.0	24.3	0.0	1.5	2.0	2.0	4.0	5.0	6.1	8.1	4.7	4.0	14.8
3	White birch 6" and 8" blocks	0.5	1.5	1.5	1.5	2.5	3.0	2.6	5.3	5.3	5.3	6.2	0.0	0.5	0.5	0.5	1.5	2.0	1.7	2.4	1.9	2.5	4.1
4	White birch 4" blocks	0.5	1.5	2.0	2.0	2.5	4.0	3.6	6.6	3.9	4.3	9.4	0.0	0.5	1.0	1.0	1.5	2.0	2.3	4.3	1.5	4.1	4.9
5	Western larch 4" blocks	2.0	2.0	12.5	25.5	13.5	14.5	12.8	24.0	24.5	19.9	20.8	0.0	1.0	5.5	10.5	6.5	7.5	6.6	12.0	12.2	10.0	9.9
6	Western larch 6" and 8" blocks	3.5	3.5	26.0	35.0	24.0	35.5	41.0	40.0	36.7	33.4	33.4	0.0	2.0	13.5	14.5	14.0	16.5	24.7	28.0	19.2	16.6	20.0
7	Longleaf pine (Laid in 1911)	---	---	---	---	0.2	1.0	1.3	1.5	1.3	1.3	2.6	---	---	---	---	0	0	0	0	0	0	0
8	Douglas fir (Laid in 1911)	---	---	---	---	1.0	4.5	4.7	5.3	4.5	4.5	3.5	---	---	---	---	0	0	0	0	0	0	0
9	Longleaf pine	0.5	0.5	1.5	1.5	3.0	5.5	3.2	8.9	9.8	9.1	11.9	0.0	0.0	0.5	0.5	1.5	2.0	1.6	1.0	1.3	1.7	7.1
10	Eastern hemlock	1.0	1.5	5.0	5.0	5.5	11.0	10.0	18.1	16.4	19.7	23.1	0.0	0.5	2.5	2.0	2.5	5.0	4.4	7.4	7.8	10.7	11.5
12	Norway pine	---	---	2.1	3.0	4.5	6.0	6.0	5.6	8.0	11.0	12.0	---	---	---	---	2.0	2.0	2.8	2.0	3.4	4.0	4.0
13	Norway pine	---	---	0	3.0	4.5	9.0	5.8	8.0	9.0	8.9	10.7	---	---	---	---	1.5	3.5	2.5	3.5	3.4	2.1	3.6
14	Norway pine	---	---	0.9	1.0	1.0	4.0	2.9	2.0	2.2	1.8	2.5	---	---	---	---	0.5	1.5	1.4	1.0	1.2	1.0	1.4

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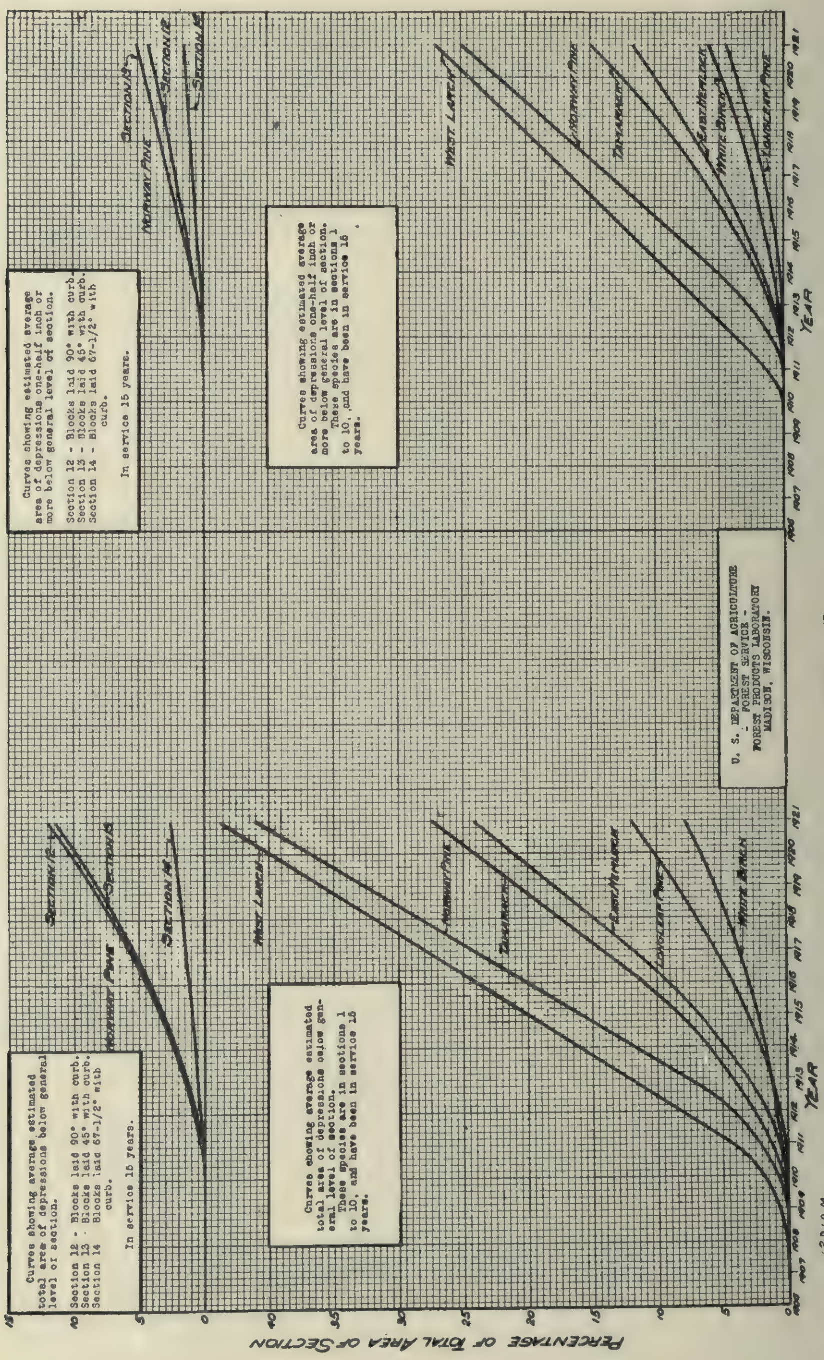


Curves showing average estimated total area of depressions below general level or section.

Section 12 - Blocks laid 90° with curb.
Section 13 - Blocks laid 45° with curb.
Section 14 - Blocks laid 67-1/2° with curb.

In service 15 years.

Curves showing average estimated total area of depressions below general level of section.
These species are in sections 1 to 10, and have been in service 15 years.

Curves showing estimated average area of depressions one-half inch or more below general level of section.

Section 12 - Blocks laid 90° with curb.
Section 13 - Blocks laid 45° with curb.
Section 14 - Blocks laid 67-1/2° with curb.

In service 15 years.

Curves showing estimated average area of depressions one-half inch or more below general level of section.
These species are in sections 1 to 10, and have been in service 15 years.

U. S. DEPARTMENT OF AGRICULTURE
- FOREST SERVICE -
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN.

Fig. 3

The early failure of this wood was probably due to a poor quality of material used in the original construction. For a further test of this species a part of the same section was re-laid with a better quality of wood. Only a limited supply of these blocks could be obtained at the time and the remainder of the section was therefore paved with the standard yellow pine blocks furnished by the city.

Figure 4 shows the location and size of the sections at the present time. In this figure the sections numbered 1 to 10 are those containing the different species for a comparative test, and sections 12, 13 and 14, are sections of Norway pine laid for a comparison of the wear on blocks laid at different angles with the curb.

Relative Wear of Species

The curves in figure 3 give a general indication of the relative wear of the different species in the test. Since the Norway pine blocks in sections 12, 13 and 14 are not under the same conditions of wear as blocks of the other species in sections 1 to 10, the curves representing the percentage of depressions are shown separately above the other curves.

White Birch and Longleaf Pine. Both the white birch and longleaf pine are in distinctly better condition than any of the other species. However, the white birch sections have deeper depressions than the longleaf pine and their condition is not quite as good as that of the pine. This is mainly on account of decay pockets that were present in some of the birch blocks at the time they were laid and the defective material was not discovered until after it had been in service a short time. For this reason a few decayed blocks have been removed from the white birch sections. If the unsound blocks had been eliminated before the pavement was laid the birch would probably have shown about the same durability as longleaf pine.

Norway Pine. About one-half of the section originally laid with this species has been replaced during the last two years on account of wear.

From figure 2 it will be noted that the section containing these blocks is a small triangle and is situated at the intersection of Washington Avenue and Nicollet Avenue. In this location all of the blocks are under very severe wear on account of the heavy southbound traffic and the turning of trucks and other vehicles at Washington Avenue. Sections 12, 13, and 14 are no doubt more representative of the wearing qualities of this species, and the good condition of these sections would indicate that Norway pine paving blocks may be expected to give very good results.

Eastern Hemlock and Tamarack. There does not seem to be a marked difference in the condition of the sections containing these two species. While the hemlock blocks are apparently in slightly better condition than the tamarack, the difference is not of particular importance.

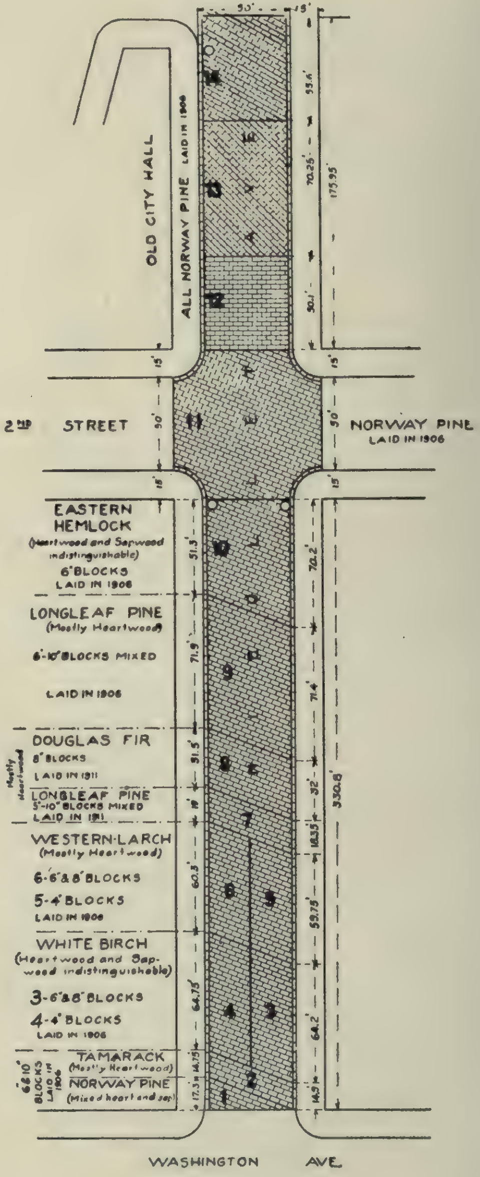


Fig. 4. Arrangement of the Experimental Pavement. Laid in the summer of 1906. Partially relaid June 27, 1911

Western Larch. The sections laid with western larch have deeper and more extensive depressions than sections laid with the other species. Apparently the sections paved with this wood will require renewal before those paved with the other woods.

Douglas Fir. Since the blocks of this species have only been in service for 10 years, as compared with 15 years for the other species, a good comparison of this wood cannot be made. While no deep depressions have developed up to the present time, the progress of deterioration is becoming more noticeable each year thru the increased area affected by depressions and the amount of wear as determined by measurement of the blocks. From the fact that these blocks have been in service twice as long as those replaced in 1911, it is evident that the first material was not of the best quality.

The longleaf pine blocks, laid adjacent to the Douglas fir material in 1911, are practically free from noticeable depressions.

Measurements of Blocks. Measurements made in July, 1921, by Mr. Dutton, to determine the average wear, showed the approximate decrease in depth of blocks of the different species in sections 1 to 10 to be as follows:

Longleaf pine	after	15	years	service—	½	inch
White birch	"	15	"	" —	9/16	"
Norway pine	"	15	"	" —	9/16	"
Tamarack	"	15	"	" —	5/8	"
E. hemlock	"	15	"	" —	11/16	"
Western larch	"	15	"	" —	11/16	"
Longleaf pine	"	10	"	" —	5/16	"
Douglas fir	"	10	"	" —	½	"

Careful observation of the surface of the pavement showed that blocks from the wide-ring or rapid-growth material, seem to be withstanding wear as well as those from the slower-growth wood. This was particularly noticeable for the larch, hemlock, birch, and pine blocks in which the number of rings per inch was quite variable.

Effect of Length of Blocks

The length of the blocks used in this experiment varied from 4 inches to 10 inches and the results seem to indicate that the length was not an important factor affecting the wearing qualities of the pavement. Whatever difference in wear may be noted between blocks of different length is comparatively unimportant and is probably due to other causes.

Influence of Heartwood and Sapwood

In the material used for this experiment the longleaf pine, Douglas fir, and western larch, were practically all heartwood. The Norway pine and tamarack were mixed heart and sap. Heartwood and sapwood were indistinguishable in the white birch and hemlock blocks.

Results of the experiment do not appear to show any particular influence of either heartwood or sapwood on wearing qualities.

Decay was found in the sapwood of some of the blocks but where this was the case the blocks had apparently not been well treated.

Comparison of Angle of Courses

Section 12, laid at 90 degrees with the curb, shows greater joint wear than sections 13 and 14 which are laid at 45 degrees and 67½ degrees respectively. The courses laid at 67½ degrees are in slightly better condition than those laid at 45 degrees. These blocks, however, are at the junction of Hennepin Avenue and Nicollet Avenue, and traffic is distributed over a larger portion of the surface. Under exactly the same conditions it is probable that little, if any, difference would be found in the relative joint wear of blocks laid at 45 degrees and 67½ degrees.

Summary

Beginning with the species showing the best results (placed in sections 1 to 10) the order of efficiency so far shown in this experiment is as follows:

(a) Longleaf pine and white birch.
(b) Eastern hemlock and tamarack.
(c) Norway pine.
(d) Western larch.

If the Norway pine blocks had been under conditions similar to those in which the other species were placed, this species would probably come next to longleaf pine and white birch in order of efficiency of service.

Since the Douglas fir has not been in service for the same length of time as the other species a good comparison cannot be made. However, the depression and wear in blocks of this species is very marked in comparison with the longleaf pine blocks laid at the same time.

There was no evidence to show a difference in the rate of wear in blocks of different length.

A comparison of the wearing qualities of blocks with and without sapwood did not show that the presence of sapwood was detrimental.

Sections laid at 45 degrees and 67½ degrees did not show as much joint wear as the section laid at 90 degrees with the curb.

Blocks of wide and narrow rings seemed to be withstanding wear about equally well.

DISCUSSION

MR. DUTTON: There has been inspection of the pavement since 1911 in conjunction with the city of Minneapolis. We have had these inspections at different times and the curves have been condensed and made up from the different inspections. In reading over the very able paper presented by Mr. McLean on the "Results obtained from an experimental treated wood block pavement after fifteen years service," there are several things that stand out prominently in this report and of great interest to the creosoted wood block industry.

There have been a great many heated discussions and arguments as to whether this or that was the proper oil, whether this or that was the proper treatment, whether this or that was the proper wood, etc. This experiment was carried out principally to determine the suitability of various woods and the results show very clearly which woods are best suited for paving work. It shows, however, that the value of the sapwood is almost the same as the heart wood and that the coarse-grained wood wears about as long as the finer grained of the same species. It does not follow that you can take a coarse-grained Douglas fir and have it wear as long as a coarse-grained Norway pine, for that is what was the matter with the original Douglas fir laid in the experiment. It *was* coarse-grained, about two rings per inch, and thoroly kiln dried at that, so it was about as light as cork. No wonder it didn't last, as the fibers were not sufficiently strong to withstand the traffic. The Douglas fir that was used the second time was much finer and closer grained wood and is doing very well for the ten years that it has been in service.

You notice the report doesn't mention anything about the quality of the oil used and shows that the blocks have worn so that some of them, at least, will have to be replaced before very long. This shows that under conditions of travel as heavy as this, the blocks will wear out before they rot out. There is another very interesting thing that has occurred since this pavement was laid and that is the change in kind of traffic. The traffic censuses taken since the pavement was laid were as follows, taken in five year periods.

Condensed Traffic Census on Nicollet Avenue between Washington Avenue and 2nd Street, Minneapolis, Minnesota

Kind	Number 1906	Number 1911	Number 1916	Number 1921
Steel tires	2858	2759	948	165
Bicycles, etc	1054	360	495	142
Automobiles	237	910	2959	3501
Trucks	....	....	425	717
Total per day	4149	4029	4827	4525

Note. This does not show the natural increase as a new bridge was constructed recently about three blocks from this street thereby diverting a large part of the traffic from this street.

This table shows quite graphically the change in type of traffic and that the horse-drawn vehicle decreased very greatly, in fact almost vanished. Motor-driven vehicles increased in as great degree and the auto-truck came into existence materially. These changed conditions of traffic have to be met by the pavements of today, but the creosoted wood blocks are just as suitable for this traffic as they were for the former kind.

This last record, of course, does not show the increase, as much as it should because of the new bridge across the Mississippi River only three blocks away which has diverted a large amount of traffic away from this street.

STREET DESIGNS

By P. L. Brockway, City Engineer, Wichita, Kan.

Streets should be of five types so far as design is concerned.

First: Informal drives, principally thru parks and playgrounds, winding here and there to reach vantage points for pleasure driving only; scarcely to be given the dignity of being called streets at all and yet merging into the street system. These do not ordinarily need to be wider than sufficient to provide for two lines of traffic, as there is no reason for parking on them and the class of vehicles using them can and should be restricted to those driven for pleasure only. They should be so located as not to invite thru traffic, even of this class, in order to keep them set apart for their intended use. The width which appears to be most economical and still satisfactory is about twenty feet. This gives plenty of room for two lines of traffic without creating an uneasy subconscious impression of being crowded, in the minds of the drivers, and so detracting from the chief business at hand, that of enjoyment.

As to the character of the improvement of the drive, much will depend on the local conditions as to availability of different materials, character of the subsoil, drainage, etc., but the surface most in keeping would be the one which harmonizes best with surroundings. A mixture of gravel and clay well kept up, would be in order almost anywhere but especially so in hilly wooded country. In level localities, where dependence is placed mainly on sodded lawns and group-planting of shrubs and trees, the light colored surface of concrete or asphalt mixtures makes a pleasing contrast. Many drives of this kind are, of course, water-bound macadam, or penetration macadam, or oiled roads. The water-bound macadam is objectionable on account of dust. Penetration macadam and oiled roads require considerable maintenance under the impact of the heavy automobile now in common use.

There should be only the least possible crown necessary for drainage, depending on the type of surface, and no curb whatever.

In gravel or oiled roads, a narrow stone gutter along each edge is advantageous in that it gives a finished appearance which is not possible if the sod is allowed to overlap the edges of the road. It also gives a guide line to follow in driving over the road, which adds to the sub-conscious ease of driving.

We have a drive of this sort two miles in length, completed this last season, which is twenty feet wide over all, with a monolithic gutter two feet in width on each side depressed one inch in the center of the two feet to carry water to suitable outlets, and with a sixteen-foot width of asphaltic concrete surface crowned two inches in the sixteen feet. The inner edge of the concrete is a big help in driving as a guide line and the driveway as a whole has received much favorable comment from landscape engineers. It was purposely laid out without any tangents either horizontal or vertical in order to contrast with our monotonous straight streets and flat uniform grades, being built in sand dunes along a river bank.

Second: Tertiary streets, which would not find much use except in rather rough country or isolated nooks or odd corners occurring in the development of a combination of rectangular and radial systems of major streets. These could be very effectively used in such localities. They should necessarily be short and, if blind at one end, should be provided with a turning loop which could enclose a small landscape planting or fountain and fish-and-lily pond. A narrow width of surfaced driveway would be necessary in order to be in keeping with the short length of the street; and because of the limited territory served, a width sufficient for a moving vehicle to pass one parked on the street would be sufficient.

These conditions would seem to be fully met by a twenty-foot roadway. The street need not be straight, in fact, if topography were suitable, curves would add to the apparent privacy and exclusiveness. Some courts of this sort have been platted without being formally dedicated as public streets at all, but rather handled by deeding an undivided interest with each building site.

The location of sidewalks, wherever possible, should be far enough back of the curb to permit group planting of shrubbery between them to enhance the sylvan effect. This would not always be possible on account of space and not desirable where the street is joined at both ends with busy thorofares. Altho probably every city has a few, it is never satisfactory to make the street as a whole so narrow that it is necessary to place the walk immediately behind the curb, except of course, in business streets.

The two chief reasons for separating the walk from the curb are that it places pedestrians too close to moving vehicles in wet weather and that it is practically impossible to cross the sidewalk with a driveway from the street without inconvenience, or even danger to both vehicles and pedestrians.

If the sidewalk is separated at all from the curb it should be far enough to give a well balanced planting space between the two, at least twice as wide as the walk and preferably not less than ten feet. On the type of street under discussion a four-foot walk will probably be wide enough. This would require a minimum street width of twenty-foot roadway, two ten-foot planting strips and two four-foot walks, or forty-eight feet. This would, of course, not always be possible. It could be narrowed to thirty-four feet by placing a sidewalk on one side only, depending on the location and use of the street.

We have recently improved some streets of the public-court character, entirely out of line of thru traffic, and at my suggestion they were paved only twenty feet wide with fairly long radii or curbs at street intersections. The parkings have had good plantings and the whole effect is that of a prosperous country place with houses back in the woods.

I have suggested a very narrow street with walks necessary on both sides, that the curb be omitted and replaced with a gutter sloping up from the pavement four inches in two feet to the usual walk so that a car could cross it anywhere at any angle and the walk would still be separated from the pavement and have no break in the surface. I do not think that arrangement is desirable but I do believe it would be better than cutting a wide driveway thru the walk at practically every fifty-foot building site as will be necessary in the block in question. There is a three per cent grade in the block so that there would be practically no danger of street water flooding the walk. My suggestion fell on defa ears because it was "different."

Concerning slopes on the planting strip in this type of street, it would seem to be rather immaterial so there is sufficient slope for drainage, on account of the informal character of the whole layout, excepting that it should be considered as a part of the treatment of the whole layout from the landscape viewpoint. Some regard would have to be given to the grade of driveways, which would also depend on the slope of the lots themselves.

Third: Secondary streets serving local districts and acting as feeders to the major street system. These would naturally be more formal, follow more direct lines and require entirely different treatment than those already discussed. They would not, and should not entirely disregard topography as is so often done. In choppy, hilly country they should in general follow the lowest ground as far as possible, leaving the interior of large blocks to be reached by the tertiary streets. If the drainage area is large so that a street at the foot of two hills would too easily flood, it might be desirable to place a street on each side of the lowest ground, treating the space between as a sunken garden with appropriate planting.

Of course if the hillside slopes are long there will be required other streets than those at the foot. These should be so located as to avoid excessively steep grades. Very pleasing effects may be obtained in rolling country if vertical curves are carefully worked out in long straight streets.

I have sometimes found it necessary to run vertical curves of the third degree, making the rate of change in grade uniform. In such cases grades must be established fairly close together and care must be used to avoid angles due to careless construction.

Nothing is more pleasing than curved roadways, either vertical or horizontal, if the construction work is well done; or more displeasing than a careless attempt to do the same thing.

Concrete curbs lend themselves readily to this class of work, as forms can be lined up far enough in advance of finished work to avoid irregularities. In establishing grades on side hills, it is generally best to favor the lots on the low side, as it is much cheaper to shape up and maintain a terrace or series of terraces on the high side than to fill up the rear end of the low lots. The planting space between the curb and walk on the high side should be much steeper than that on the low side in order to prevent as far as possible the optical illusion that the high side is the lowest. This is also helped by building the pavement with an eccentric crown.

In flat, featureless country, the rectangular system of platting is probably best for secondary streets as there is less waste ground. The only landscape treatment of much value in that case is that of giving long vistas and in order to give proper breadth the building line should be well back from the street and group planting of shrubs should not be allowed too far out from the building line.

The width of roadway in secondary streets should be sufficient for three lines of traffic, including vehicles parked against the curb. There is some difference of opinion on this point. Nearly everyone is agreed that ten feet should be allowed for the first line, after that, recommended widths for the second and third line range from eight to ten feet making the total roadway twenty-six, twenty-eight, or thirty feet. On account of the wandering habits of ice-wagons and the rather serious blocking of streets by moving-vans backed up to the curb, together with the much greater ease of turning a car having a long wheel base into private driveways, our own practice is to recommend the thirty-foot roadway although we do not refuse to improve with a twenty-six foot width.

The width of the planting strip between the curb and sidewalk should also be about ten feet in order to give a well balanced appearance to the street. This is about the least width which will support a large tree without crowning one side or the other, and it would seem to be rather an essential part of the improvement of this type of street to provide for rows of stately trees, furnishing pleasing vistas. Sidewalks on this type of street should be wide enough to allow one person to pass two without crowding. This will require a width of not less than five feet.

The total width of street on this basis will be, pavement twenty-six to thirty feet, planting strips twenty, sidewalks ten, or a total of fifty-six to sixty feet.

One detail in street design which has come into rather considerable importance in the past ten years is the length of the radius of curbs at street intersections. When horse-drawn vehicles were the only kind in use, short radii were the rule and were generally satisfactory, but with the present traffic the radius should never be less than ten feet and from that on up to anything in reason. Some states prohibit a radius longer than the width of the least parking at a street intersection, on account of some vested rights which are supposed to rest with the owner of the abutting lots. This detail furnishes another reason for making the planting strips ten feet in width, because if the curve begins very far back of the sidewalk there results an awkward angle where the intersecting walk joins the curb. In passing, it might be remarked that this is no cure-all, as there have been five serious accidents in as many weeks at an intersection of a major street, having a forty foot roadway, with a secondary street, having a thirty foot roadway, with curbs of twenty-four radius on all four corners and buildings far enough back to give fair visibility in all directions.

Another troublesome street detail is the matter of drainage in the absence of storm sewers. This may seem a contradictory condition to engineers working in some cities. It is however, a fact that, in some very flat cities where storm water tends to spread out rather than flood low points, adequate storm sewers are the last improvements the public can be persuaded to buy. There must therefore be some means provided for surface drainage in paved intersections. Three methods may be employed.

First: Construct an inlet and outlet on two corners in the direction of flow and connect with an inverted siphon. This is continually silting up on account of sluggish flow and is a constant nuisance.

Second: Construct a box culvert in the pavement in the direction of flow. This gives one of two results, either the box is so small as to be constantly choked up, or else the gutters must be depressed so low to give adequate entrance to the culvert that the result is an unsightly and even dangerous corner. I have in mind one thriving little city with curbs uniformly over eighteen inches high on this account. It gives one the impression that the whole city is walking on stilts.

Third: Depress the surface of the pavement to the elevation of the gutters in the line of flow. This is the surest method of disposing of the water in any kind of storm, but unless handled carefully is very objectionable to vehicular traffic. We have adopted as a standard change in grade in the approaches to the open gutter, three feet distance for each inch of total crown. These slopes do not make an abrupt ditch at their intersection and are not at all objectionable to any type of motor car travelling at any reasonable speed. We have not, however, used this type on streets of our next classification, preferring generally the inverted siphon.

Fourth: Streets included in the major or primary thorofares. These streets to be located primarily for one purpose, to facilitate the movement of all sorts of street traffic to the various centers, from each other, and from the residence and suburban districts and from the surrounding country. To gain this purpose they should be as direct as possible, both horizontally and vertically, which would mean that they could not entirely disregard topography and natural obstacles, but that, depending on the traffic requirements and the wealth of tributary territory, considerable money might be spent in reducing grades or bridging rivers in order to obtain more direct routes. In fact, increasing traffic concentration in some of the larger cities makes almost imperative the expenditure of vast sums not only to overcome natural but also artificial obstacles.

There could scarcely be any fixed rule as to the location of such streets, beyond the statement already made. Each city presents an individual problem as to its general traffic movement and would have to be so treated. In fact, it would seem wise to rather emphasize this fact in order to give the city individuality.

As to the width of these thorofares, this would require individual study of traffic flow, its past, present, growth, and probable future. It would not seem wise, however, to provide for less than four lines of traffic if the street is at all important, which under the rules already mentioned would require a roadway of thirty-four to thirty-eight feet, tending toward the latter on account of the higher speed of part of the traffic. Streets containing street-railway tracks should be just as much wider than these figures indicate as the space required for clearance of the street cars, probably eighteen feet more in streets having double tracks, as the tracks should not be permitted to be so spaced that a person could not walk between them without being "rolled" to death. This would make a total width of roadway of fifty-six feet in this case. To residents of many cities this will doubtless seem a waste of ground but it is quite common and often exceeded in many western cities.

Traffic counts may be misleading unless all the facts are known. If cars uniformly spaced on one-hundred-foot centers and traveling at twenty miles per hour passed a given point, 1056 per hour would be counted in a single line of traffic. This could scarcely be realized in actual traffic conditions, especially on city streets, on account of interference of cross traffic. For example, a recent traffic count on a street containing a double street-car line on fifty-foot roadway, where there was very little interference of cross traffic for a thousand feet in either direction, showed that over a thousand pleasure cars in addition to a third as many more slower moving vehicles were passing each hour. There was no crowding or confusion and twice as much traffic could have been easily accommodated. Another count on the same street of the same effective width, but with probably half as much cross traffic at each intersecting street, showed very little more traffic but constant congestion and delays.

This point is brought out only to emphasize the fact that each street will require individual treatment and different treatment in different places according to local conditions.

Thorofares of thirty-eight-foot roadway should have planting strips not less than fifteen feet in width in order to appear well balanced and to insure greater range of vision at intersecting streets. Walks should ordinarily be wide enough to accommodate three abreast, six feet, making the total street width eighty feet. Another point in favor of this minimum total width is that, as the business section follows out along the street, the planting strip can be eliminated and the roadway and sidewalks widened to cover it, the relative widening depending on the relative importance of the two types of traffic. It is likely, however, that with this total width the walks should not be less than 12 feet, nor more than 15 feet on each side. With this ultimate improvement in mind, it would seem highly desirable to fix the cross section of the street as a whole in a rather rigid, formal manner in order to avoid the confusion and expense of changing walk elevations later.

Eighty feet is indicated as the minimum desirable width for a really important thorofare and, while probably sufficient for most streets, should be increased in important business thorofares carrying both local and thru traffic to such a degree as to avoid needless delay, or else alternate routes provided. This latter course is often the simplest and best way out of a serious dilemma, on account of prohibitive cost of moving or cutting fronts from existing buildings. As an extreme measure the front portion of the lower floors of business buildings have been set back, using the space so gained as an arcade and occupying the whole of the original street for vehicles. This is most undesirable and should be employed only as a last resort. However, volumes could be and have been written on this particular branch of street design and still each problem is peculiar to itself.

We have used a somewhat different plan in widening roadways from that ordinarily recommended. Certain streets were required to be widened on account of change from residence to business use before the original pavement was worn sufficiently to justify its removal. The crown of the original pavement was also excessive, so that if continued for additional width, it would require an excessively high curb and the ultimate destruction of the whole pavement to make a satisfactory traffic way. Therefore the only change made included the removal of the curbs to the new lines and the construction of pavement in the intervening strips but with the new portions sloping down toward the original gutter line. This permitted the curb to be set higher to fit existing walks which, of course, sloped down away from the building line, and still have only a reasonable height showing above the pavement. It will be possible also, when the surface of the original pavement must be renewed, to build up over the old gutter line with new concrete and have a crown of reasonable height and contour over the street as a whole without destroying the old base.

Another very satisfactory detail was that of the driveway entrances to certain garages in the block. The driveway approaches were built practically entirely in front of the curb for a distance of about four feet and with easy approach grades at each side. These do not interfere with walk or street traffic either to any objectionable degree. I have thought, in fact, that this might be the best street contour for auto rows or other streets with no planting strips and many driveways across the walks.

Curb heights vary, but most localities use six to eight inches. The best practice would indicate a height which would not be inconvenient to step over, especially in business streets. It is also desirable to raise the gutters up to the top of the curbs at all sidewalk crossings in order to avoid any stepping up and down whatever and, of course, there should be no open, uncovered openings to step across. This detail is easily arranged by raising the elevation of the whole intersection and depressing the gutters for a short distance at the corners of the intersecting walks. This corner depression also serves to keep vehicles off the sidewalk. Adequate storm sewers are necessary with plenty of inlets at all corners toward which there is any surface drainage. Sidewalk slopes of about one foot drop to forty feet width are most satisfactory and are fairly representative of standard practice.

Fifth: Broad formal boulevards designed primarily as pleasure drives with wide vistas and elaborate landscape treatment, often terminated at a monumental civic center or outstanding natural feature of the city.

The design may include two or three or even more separate roadways divided by gardens and lawns. In any event so much is involved in the successful design and maintenance of such a project that it should be undertaken only by landscape engineers and architects of wide experience.

THE MANAGNAN-SUCHER PROCESS FOR PRESERVING AND TRANSFORMING WOOD

By Arthur C. Smith, Chief Engineer Franco-American Wood Transformation Corporation, Wallingford, Conn.

There are many processes of wood preservation in use at present, which may logically be grouped into three classes, as follows: (1) water-soluble preservatives, such as copper sulphate, mercuric chloride, zinc chloride, and sodium fluoride; (2) crude oils; and (3) creosotes of various kinds. All of these preservative agents, however, are employed to increase the length of life of the wood solely by retarding its decay, and, beyond accomplishing this more or less effectively, do nothing toward improving the wearing qualities and other mechanical properties of the wood treated. In fact, many agents used in the preservative treatment of wood are commonly regarded as causing a deterioration of its mechanical properties.

Since our forests have been largely culled of the better kinds of wood, which not only becomes scarcer but more expensive with each succeeding year, it becomes imperative in making use of the more inferior woods that are not only subject to decay but often weaker mechanically, that we should treat them with such a preservative as will not only lessen their susceptibility to decay but will at the same time compensate as far as possible for their natural shortcomings. Briefly stated, the problem is to make of a soft, porous wood deficient in resistance, or of a hard but "brash" and inelastic wood, both of which are subject to decay, a wood that shall be resisting, elastic, water-proof and rot proof.

The process which I desire to present for your consideration definitely solves this problem. It goes a step farther than the processes now in use, in that it not only adds to the length of life of the wood by retarding its decay, but it likewise simultaneously transforms its physical nature completely, giving the wood greater resistance to mechanical stresses and repeated shocks.

This transformation is brought about under pressure by means of a bath of tar, to which is added an alkaline liquid of special composition. The latter serves as a solvent for the tar and, thru its action on the silicified cell walls, renders them more favorable from a physical standpoint for its dialysis thru the cellular tissues of the wood. During the process of treatment a large quantity of the free water in the wood is evacuated, carrying with it the albuminous, starchy, and other substances of the cell contents, which are the very elements in the wood that are first utilized as food by wood-destroying fungi. Upon the completion of the treatment the wood is found to be well impregnated with a mixture of tar and silica, which, by reason of its two-fold properties as an antiseptic and an occluding agent, assures an efficient preservation of the blocks. The ligneous tissue is thereby transformed and the preservative materials are fixed into the wood without subsequent sweating out; at the same time the wood is found to have acquired a remarkable suppleness and elasticity. In addition the blocks are covered externally with a coating of tar and gelatinous silica which forms, when the blocks are laid, an excellent water-proof joint. Furthermore, the wood can be handled immediately after its treatment without danger to the clothes or the hands of the workmen handling the same.

The chemical and physical action on the wood of the Managnan-Sucher wood preservative process, which originated in France, have been investigated in detail and enthusiastically reported upon by Dr. Louis Tissier, Professor of Industrial Chemistry, of the Faculty of Sciences at Besancon, by Dr. Piguet, of the Licentiate of Physical and Natural Science in Paris, and by others. Highly commendatory reports and testimonials have also been given by various municipal engineers in France and Russia. Those of you who may be interested in the details of the Managnan-Sucher process and in the way in which wood treated by it has stood up under actual service tests in various parts of Europe, can secure copies of these translated French reports.

The practical utility of the Managnan-Sucher process of wood preservation has been confirmed in every particular by the paving tests carried on by us in Paris and other parts of France, and also in Odessa, in southern Russia.

The wood pavement laid in Paris, in the Place de la Republique in 1907 and in the Rue de Rivoli in 1909, both streets with heavy traffic, has been examined from time to time by the engineers of the Municipal Council of Paris. According to their measurements, the average surface wear of this pavement has been less than one millimeter per year, whereas the average wear of pavements in the same section, treated by other processes, has been in the neighborhood of one centimeter, or ten times as great.

I personally visited the Place de le Republique last June while workmen were taking up this pavement, and examined many of the blocks. The cohesion of these blocks was so great that entire groups of blocks would come up without separating from one another. I failed to find a single block that showed any sign of decay whatsoever, a point that has been verified subsequently by a microscopic and microchemical examination of the wood. The same examination showed that the blocks still contained an abundance of the preservative materials and that, in this respect, the wood was not to be distinguished from that of recently treated blocks.

The total wear in 13 years amounts to less than one inch, whereas the average wear of paving treated by other processes amounts to one inch every two and one-half years, a total of more than five inches in the 13 years. Three other pavements have been worn out and replaced alongside of this pavement, while the test pavement itself has not had the outlay of a single franc for repairs during this entire period of 13 years.

Examinations and reports by engineers from Odessa show that, after two and one-half years' use, the section of paving treated by the Managnan-Sucher process was entirely satisfactory in every way. It showed much less surface wear, was more impervious to moisture, dried off more quickly after a rain, and was much less slippery than the wood block paving treated by other processes. In addition, this section of paving was proof against the heaving and bulging caused by the abrupt changes in temperature, which in this locality range from 95° above, to 40° below zero.

The results secured in paving wood can be achieved in other woods, both in soft woods like poplar, and in hard woods like oak or beech. Each of these kinds of wood acquires the same qualities of resistance, elasticity, and durability after the treatment. The numerous applications to which woods, no matter what the species, are suitable when treated by the Managnan-Sucher process, can thus be readily seen.

One of the most pressing needs of America today is to secure a method of treating railroad ties, not only to preserve them from decay but, what is more important still, to increase their elasticity and thus prevent the cutting and crushing at the point of contact of the rail and the tie, due to the continual shocks caused by heavy freight and passenger traffic.

The different methods of treatment in use at present, fail in the most important of these, namely the retention and increase of the natural elasticity of the wood. The Managnan-Sucher process, however, definitely solves this problem, as this mode of treatment not only drives out the most putrefactive elements in the wood and protects it from future decay but simultaneously increases the tensile strength of the wood, thereby preventing the crushing and flattening of the tie, and affording an unusual length of life to the same.

Another distinct advantage is claimed for the Managnan-Sucher pricess in that it is not only possible but decidedly preferable to treat the wood while it is still green. The desirability of treating green or unseasoned wood can be readily seen, since the removal of the putrescible matters, which is one of the aims of the Managnan-Sucher process, can be easiest done while the wood is still green, for, during the process of seasoning there takes place a fixation or perhaps a transformation of these organic and inorganic materials in the wood, which renders their removal more difficult.

These so-called "putrescible" matters consist chiefly of the cell contents which, as a rule, are first attacked by the fungi before the cell walls themselves, since they constitute a source of food which the fungus can more readily assimilate. Once this readily available source of food is removed from the wood and the wood tissue injected with a preservative that will prove toxic to the growth of wood-rotting fungi, the wood may be regarded as fairly immune to decay.

The financial economy of such a mode of preservative treatment as the Managnan-Sucher process, which is able to successfully treat unseasoned wood, will at once be readily apparent to all. The ability to successfully treat green wood, which is lacking in practically all the preservative processes now in use in this country, means that both a vast amount of overhead expense and trouble can be saved the operator by obviating the necessity of storing the wood for periods of several months, as is commonly done, to secure its seasoning before the preservative treatment can be administered.

Moreover the same would eliminate a large amount of decay which is apt to occur in wood that is held any length of time for seasoning, particularly in those sections of the country where the climatic conditions and perhaps also the storage conditions are such as to invite a speedy attack by wood-rotting fungi.

As applied to railroad ties, the Managnan-Sucher process therefore insures for a minimum cost, the prevention of decay, an increased resistance in soft woods, and the possible utilization of all kinds of wood. It may also be utilized profitably in all other construction and industrial purposes in which wood is used, such as mine timbers, bridge timbers, piling, telegraph poles and cross arms, flooring, fence posts, etc.

By reason of its ability to improve the natural mechanical properties of the wood, the Managnan-Sucher process of preserving and transforming wood renders utilizable the more inferior woods which, up to the present time, have not been considered utilizable by reason of their lack of mechanical strength. It will thus be seen that the Managnan-Sucher process opens the way for a veritable revolution in the utilization of all kinds of woods, and is a most important step in the conservation of our rapidly diminishing forest resources.

COOPERATIVE INVESTIGATION BY THE U. S. BUREAU OF PUBLIC ROADS UPON THE CAUSE AND CORRECTION OF SHOVING OF ASPHALT PAVEMENTS

By Prevost Hubbard, Chemical Engineer, The Asphalt Association New York City

In common with other types of pavements many cases of defects in asphalt pavements are due to foundation or subgrade troubles. While the shoving of asphalt pavements is most often attributable to such troubles it is nevertheless true that in some cases shoving has occurred from other causes. For this reason during the summer of 1921 an investigation of the cause and correction of shoving of asphalt pavements was undertaken by the U. S. Bureau of Public Roads with the cooperation of the cities of New York (Boro of Manhattan), Philadelphia, Baltimore, Washington and Detroit, and the Asphalt Association. At the time this paper is written the investigation is in its initial stages and no results have been obtained or conclusions drawn. It has been suggested however that an outline of the investigation would be of interest to quite a number of engineers who would wish to keep in touch with the progress made and could, from their own experience, offer many helpful suggestions. What follows therefore should be considered only in the nature of an outline together with a brief consideration of certain elements which it is believed may have an important bearing upon the subject.

In the first place shoving or tendency to shove is not an inherent characteristic of asphalt pavements, as evidenced by millions of square yards of satisfactory surfaces varying from one to forty years or more in age and subjected to all conceivable conditions of exposure and traffic. It is rather to be considered as an occasional manifestation which in many cases may be corrected by cutting out the deformation and replacing the old wearing course mixture with new, thus forming a patch. More often than not, when waves or deformations are noted in an asphalt pavement most of the adjacent surface in the same line of travel and with the same exposure is found to be true to contour. Except where failure of the foundation is evidently responsible comparatively few cases are to be found where a high percentage of the wearing course even in the direct line of travel has shoved. It would therefore appear that where shoving occurs some condition or combination of conditions is responsible which if thoroly understood would make it possible to prevent absolutely such defects in future construction.

Whatever the conditions are which make shoving possible, the primary cause of shoving is traffic, which produces a rearrangement of the mineral particles in the paving mixture to an appreciable depth from the surface down. On pavements which are sufficiently wide to allow two lines of traffic in each direction it will ordinarily be found that the formation of transverse waves is most prevalent near the gutter, where most of the horse-drawn and slow-moving-motor traffic finds its way. While it is probably true that the impact of fast-moving traffic will accelerate shoving, once started, or may be directly responsible where irregularities in contour first existed, comparatively slow moving heavily loaded vehicles are believed to be the predominating cause.

In addition to the formation of transverse waves, which seldom extend entirely across the road, rutting is sometimes noted. This is almost invariably due to the very close tracking of vehicles and usually extends for a considerable distance in two continuous parallel lines about as far apart as the ordinary spacing between the wheels of vehicles. Rutting is due to lateral displacement of the paving mixture, which seldom occurs in wave formation, altho around curves and at intersections waves due to the side thrust of vehicles are sometimes to be found.

Certain general conditions which tend to promote shoving by producing an unstable paving mixture are quite well understood, but it is believed that there may be much yet to be learned regarding the limits of such conditions. These and other conditions are listed below for the purpose of illustrating the complexity of the subject from a research standpoint.

Conditions Which Tend to Promote Shoving

Foundation Faults.

1. Lack of support from below causing local settlement of the foundation.
2. Uneven contour in foundation causing variable thickness of asphalt paving mixture and consequent differences in compression.
3. Very smooth foundation which may promote slipping of the asphalt paving mixture over its surface.

Inferior Paving Mixture.

4. Use of too soft an asphalt cement for the climate, traffic, or the grading of the mineral aggregate.
5. Use of too much asphalt cement in the paving mixture.
6. Poor grading of mineral aggregate, which creates instability of the paving mixture irrespective of the consistency and percentage of asphalt cement with which it is mixed.
7. Use of an excess of rounded particles of mineral aggregate in the paving mixture.

Construction Faults.

8. Uneven contour due to faulty spreading, raking or rolling, of the paving mixture during construction or lack of uniformity in the composition of the paving mixture.
9. Lack of proper initial compression during construction, which may be due to use of too light a roller, too little

U. S. Bureau of Public Roads, Wash., D. C.
The Asphalt Association, New York, N. Y.
City of ....

Investigation of Asphalt Pavements, Record Sheet

Sample No.......... Type..........

GENERAL INFORMATION:

1. City.......... 2. Location..........St./Ave. from..........St./Ave. to..........St./Ave. Direction..........
3. Width..........ft. 4. Area..........sq. yds. 5. Grade: a. Ave..........%. b. Max..........%. c. Min..........%. 6. Crown..........ins.
7. Gutter.......... 8. Car tracks?.......... Distance from track to curb..........ft. 9. Exposure..........
10. Weather conditions during service: a. Temperature min..........°F; max..........°F; mean..........°F.
b. Precipitation, annual ave..........ins. Days fair..........%, cloudy..........%, stormy..........%.
11. Traffic· a. (light, medium, heavy) b. One or two way ....

c. Traffic count					
Date					
Hours					
Horse vehicles					
Automobiles					
Motor trucks					
Total					
Ave. per hr.					

12 Maintenance: a. Character.......... b. cost per yr..........c. per sq. yd. c. Cost past yr..........c sq. yd.
13 Condition: a. General.......... b Area wavy..........% c. Cracks..........per 1,000 ft.
14. Special conditions which might influence shoving?..........
....

SPECIFICATIONS:

1 Foundation· a. Type.......... b. Thickness.......... in. c. Finish..........
2. Surfacing· a. Thickness binder..........in. b. Thickness top..........in.
3. Rolling· Max. sq· yds. per hr, rolled.......... 4 Uniformity of contour..........

PAVING PLANT AND CONSTRUCTION RECORD:

1. Date of paving.......... 2. Sq. yds. laid on that date.......... 3 Weather conditions when laid..........
4. Character of subgrade.......... 5. Roller: a. Type.......... b. Weight..........tons.
6. Temp mixes· a. At plant; binder..........°F. top..........°F. b. At delivery; binder..........°F. top..........°F

7 Binder stone..........
Kind ....
Source ....

1½-1¼"		
1¼-1"		
1 -¾"		
¾-½"		
½-¼"		
¼"		
Total		

8. Sands..........
Kind ....
Source ....

¼- 10				
10- 20				
20- 30				
30- 40				
40- 50				
50- 80				
80-100				
100-200				
200				
Total				

9 Filler..........
Kind ....
Source ....

30- 40	
40- 50	
50- 80	
80-100	
100-200	
200	
Total	

10. Asphalt cement	Binder	Top
Kind		
Penetration		
Lbs. flux per 100 R. A.		

11. Time of mixing
a. Binder..........min
b. Topping..........min

12. Box Weights and Proportions.

a. Binder	Wt.	%	Wt.	%
Stone				
Sand				
A. C.				
Total				

b. Topping	Wt.	%	Wt.	%
Sand				
Filler				
A. C.				
Total				

c. Sands

Source	Parts

SAMPLING RECORD:

1. Date of sampling .... 2. Location: a. Position on street..

b. Distance from curb..........................ft. N. S. E. W. c. Distance from car track..........................ft. N. E. S. W.

3. Exposure.............................. 4. From hump, depression, rut, uniform contour?..

5. Thickness: a. Foundation..............................ins. b. Binder.............................. c. Topping..............................ins.

6. Character of Base.............................. b. Finish.............................. 7. Character of subgrade..............................

8. Evidence of gas, water, oil drip, parking space or other peculiar condition ....

....

TEST RECORDS:

1 Whole sample	City on Sample	B. P. R. on Sample
Thickness: Total		
" Binder		
" Topping		
Density		

2. Binder	Orig. Lab.	City on Sample	B. P. R. on Sample
Density			
1½-1¼			
1¼-1			
1 -¾			
¾-½			
½-¼			
¼			
Bitumen			
Total			
Sp. gr. coarse agg.			
Sp. gr. fine agg.			
Sp. gr. bitumen			
Per cent. Voids			

3. Topping	Orig. Lab.	City on Sample	B. P. R. on Sample		
			Entire	Top	Bottom
Density					
¼- 10					
10- 20					
20- 30					
30- 40					
40- 50					
50- 80					
80-100					
100-200					
200					
Bitumen					
Total					
Sp. gr. Sand					
Sp. gr. Filler					
Sp. gr. Bit					
Per cent. Voids					
Maximum Practical Density					
Per cent. Voids					

4. Asphalt cement	Orig. Lab.	City on Sample	B. P. R. on Sample
Specific Gravity			
Penetration			
Soluble in			
Ash			

rolling, to the mixture being too cold when rolled, or too great thickness of course for a single rolling operation.

10. Faulty repairs to service openings.

Exterior Causes.

11. Absorption of an excess of oil or gasoline drippings, causing undue softening of the asphalt cement.
12. Gas leaks from mains below the pavement structure, causing undue softening of the asphalt cement.

It is evident that a comprehensive investigation of the shoving of asphalt pavements must take cognizance of the factors just mentioned in arriving at any general conclusions. With this in mind it is planned to study the subject from a number of angles. To start with, existing pavements having the most complete history records available will be examined and samples taken from these pavements for complete laboratory tests. Already about forty tentative locations have been selected in each of the five cities whose cooperation has been secured and samples of the pavements are being taken under the supervision of the U. S. Bureau of Public Roads. These locations have been carefully selected so as to obtain samples from the same pavement as close together as possible, where the surface shows (1) a marked hump, and (2) depression, and (3) an area of uniform contour, as well as from pavements which have shown no indication of shoving.

It was hoped that samples might be taken by means of a core drill mounted on a truck which would proceed from city to city until the entire lot has been secured. It was found however that the core drill could not be used successfully for this purpose and it was decided to cut out samples approximately 1 foot square by means of an asphalt cutter and to saw each sample into 4 sections after it had reached the laboratory. The saw used for this purpose consists of a revolving carborundum saw having a steel center, to which is cemented a rim of carborundum and which is operated with a plentiful supply of water under pressure. From each large sample two small sections are to be examined by the municipal laboratory and two by the Bureau of Public Roads so that all results will be checked.

A comprehensive record sheet has been adopted for use in connection with each sample and in every case will be filled out as completely as possible. The reproduction of this sheet here shown covers in detail five broad subjects, (1) general information, (2) specifications, (3) paving plant and construction record, (4) sampling record and (5) test record. The sheet was prepared primarily for use in connection with sheet asphalt and fine aggregate asphaltic concrete pavements as it was thought advisable to limit the investigation for the time being to these types.

The laboratory tests on samples will consist in a determination of the density of each course of paving mixture and in some cases of the upper and lower half of the wearing course. The samples will then be extracted with a suitable solvent to determine the percentage of bitumen and to recover the mineral aggregate for an accurate mechanical analysis and specific gravity determination. The bitumen will also be recovered for a determination of its specific gravity, but information relative to its consistency or penetration will be obtained either from the original municipal laboratory record or from a direct determination made upon an original file sample if it is available. While it is realized that the consistency of the asphalt may have changed during its service in the pavement, no reliable method has as yet been devised for ascertaining its consistency from a sample of extracted bitumen.

From the determinations of specific gravity of the constituents of the mixture and the weight proportions in which they were combined, the maximum possible density of the mixture may be calculated and the actual percentage of voids in the pavement sample may then be ascertained by comparison with the density determination first made. By heating a portion of the original sample until it has softened to a sufficient extent it may be compressed to its maximum practical density in a mold, and by a comparison of the density of this specimen with its original density some idea may be obtained as to whether or not the pavement shows lack of compression.

All test results will be carefully considered with respect to the other data shown on the record sheets, including character and finish of foundation and character of subgrade, before any tentative conclusions are drawn. It is hoped that from examination of the pavement samples sufficient information will be secured to indicate the character of paving mixtures which are most resistant to displacement under service conditions. If this can be done, it is then proposed to prepare laboratory specimens of compressed paving mixtures and subject them to a test for resistance to displacement. While all of the details of this test have not as yet been worked out it is expected that specimens will be prepared with various mineral aggregates and asphalt cements, of different densities after compression and tested under carefully controlled temperature conditions with a device which is at present being designed by the Bureau of Public Roads to duplicate as closely as possible the shoving effect of traffic. When these tests are checked with the data obtained from the pavement samples, it may be found quite practicable to develop a set of limiting conditions which will point the way to improvements in existing specifications or at least emphasize the necessity of more careful conformity with certain requirements of existing specifications.

Provided the results of such an investigation are sufficiently encouraging it is hoped to prove or disprove the conclusions which may be developed, by means of an accelerated service test on experimental sections of asphalt pavement laid on a large circular track over which an automobile truck will be run automatically for a sufficient length of time.

As previously stated this paper is only an outline of the investigation which is at present in its initial stages and it is hoped that engineers who are interested in the subject will feel free to discuss the proposed methods and offer suggestions or criticisms that may prove of value in perfecting the various details which are still to be worked out. All first reports of the results of the investigations will be issued by the Bureau of Public Roads which is directing the work. The Asphalt Association is of course greatly interested in the subject and the writer takes this occasion to acknowledge the courtesy extended him by the Bureau in permitting him to present this outline to the members of this Society.

DISCUSSION

MR. DOW: Mr. Hubbard's investigation is really a very valuable one and of great interest. In reading over his paper I find he does not outline the various conditions which tend to promote shoving, but gives merely the skeleton of the various headings under which they were tabulated. I find this table omits the most prolific cause of shoving. That is the moisture coming up thru the foundation into the underneath portion of the wearing surface. I have investigated this subject very extensively, and believe in about 1900 I published a report on the cause of shoving of pavements at that time, and I found that about 80% of all shoving was caused primarily by the moisture. Of course, all of the factors mentioned aid in accelerating the shoving. Mr. Hubbard has mentioned gas leaks from mains under pavements as being one of the causes. A very interesting investigation was made on M Street in Washington, D. C. at one time in securing testimony for a lawsuit. It was quite definitely proven that a pavement might be badly softened from gas and yet not shoved until the water action took place. There is a diagram of that pavement in the courthouse in Washington made by myself showing the various portions as they were taken up, which ones contained gas and which ones contained water and gas and which ones were not acted on at all. There was a considerable area containing gas that did not shove. I also find that the crushing of the binder is a cause for shoving, but the entire causes cannot be discussed, of course, at a time like this, and I would like to correspond with the committee on this investigation at a later date.

MR. HUBBARD: In connection with the effect of moisture, probably in 95% of the samples that were taken where the concrete base was used, the concrete base was found to be either moist or damp. That applied to good samples of pavement as well as to those that had shoved, and that to my mind indicates the fact that it is only probably in extreme cases that water action will actually be responsible for shoving.

MR. MACGREGOR: Last week at Philadelphia I showed a few slides of serious rottings on upper Fifth Avenue. It has been suggested that that was a sample of our common pavements in New York city. I wish to correct that impression if it is abroad. That was but shown as a fearful example of rotting. We have very little trouble with rotting in Manhattan, or in fact, in New York City at all.

MINOR REPAIRS TO SHEET ASPHALT PAVING

By August E. Christhilf, Highways Engineer, Baltimore

The question of the proper and most economical manner of making minor repairs to sheet asphalt pavements has been before me for some time, and I have given some thought to what appears to be the lack of an efficient apparatus or outfit that would cover this work.

The burners or heaters of the Lutz type are not adaptable to this work, and the usual method of cutting out, concreting and hauling hot stuff for a number of miles, and keeping it in a wagon or truck until it gets cold, is certainly not efficient, whether done by contract or by municipal forces.

The cuts made in our sheet asphalt pavements are small in area, and generally distributed over a wide area, which makes the cost high, and makes the work unattractive to a contractor. The contractor will not start a plant for a few yards, and if the municipal forces do not make temporary repairs, or have an asphalt plant, the hole remains there until enough yardage has accumulated to make it worth while.

Following this line of thought, I inquired of several cities if they had ever considered the question of a portable plant for such work, and found that while some experiments had been made, they had not turned out satisfactorily, and were abandoned. I also investigated the plant builders, and found only one outfit that was developing the idea, and in my judgment they do not solve the problem.

I have in mind a small outfit on wheels, containing a burner, to supply the necessary heat, with compartments to heat and keep warm the necessary paving mixtures. I do not think it practicable to make an asphalt mixture in such a plant in a down town street, but if the top mixture were mixed at a plant and delivered to the street outfit, it could be kept hot until used up; or a mixture could be made and stored in loose piles, and when needed the non-compressed mixture could be heated in this outfit, when the plants were not running, and used for emergency repairs. Such an outfit could contain compartments for hot asphalt cement, top mixture, heating irons, and a bin for portland cement, and in the hands of good workmen would make very satisfactory patches.

I do not think it practicable to heat the materials separately, and try to mix them on the job, as the making of a stable mixture is an exact operation, and should be done by men trained in this work. If done on the street by repair-men, we would more than likely get unstable mixtures that would soon push out, and leave the pavements in as bad condition as before being patched, with a resulting waste of money.

Of course, this outfit would not be adaptable to large areas, such work being properly done by the regular plants, but should be proper for all small cuts, the majority of which run about one to three yards.

By this means, a load of topping would be placed in the heater, and could be kept hot indefinitely, allowing the patch gang to work full time, moving along from cut to cut and completing their work. There would be no necessity for using binder in these patches, as the pavements are usually worn so that if binder is used we get a very thin topping, and it is much more difficult to get a good joint than with topping alone.

Such an outfit should be particularly useful in small towns, when they have an area of asphalt, laid by contract, and where there is not enough business to support an asphalt plant. I have seen many instances of this kind, where the sheet asphalt pavements are going to pieces for want of attention, and the towns are not able to get a contractor to bring in a plant for the small area involved. In such cases patches are usually made with stone and poured with bitumen, or are filled with cold patch mixture, both methods being inefficient and tending to ruin what might be a good pavement.

Altho I have thought over several types or methods to arrive at this outfit, I am not convinced whether it would be better to have the heater outfit with power, or without. I incline to the belief that it should be without power, and so built that it could be placed behind a small truck and hauled from one location to another, or else moved by a team. If this method were adopted, the truck could serve the heater with hot material and move it.

The suggested capacity would be not over one ton of hot sheet-asphalt mixture. If the outfit were successful, it would be a simple matter to enlarge the idea and if necessary, add self-motive power.

The advantage of this outfit would be that each patch gang could start its patches in the morning and work a full day, having hot mixture available at all times; could close up cut-out places at once, and not have several blocks with holes waiting for hot stuff. At night, or if weather caused a lay-off during the day, the heater could be kept heating and the topping would be ready to work as soon as work started next morning.

I would like to see this idea developed, and believe it would result in more efficient patchwork, and allow us to close up the cuts more promptly. This is the real object in view, as the convenience of the public is of the first importance in our city work. If any of the municipal engineers have done any work on this line, it would be interesting to have their views, and any suggestions pertaining to this subject.

DISCUSSION

MR. HOWARD: A good apparatus for transporting hot paving material for use all day, is found in the French book "Axphalt et des Bitumes" by L. Malo, Paris, 1866, with complete plans of it. This apparatus is still used for patching asphalt pavements in Paris and elsewhere. It consists of a cylinder with a screw and paddles which keep the material mixed when the vehicle is drawn by horses or otherwise. A small fire of coal or coke is under it. It can also be turned by a crank on the side if it has to be heated and mixed before you start to repair asphalt pavements.

THE ECONOMICAL EXTENT OF PAVEMENT REPAIRS AND MAINTENANCE

By George H. Norton, City Engineer, Buffalo, N. Y.

That a fair determination may be made of the problem it is necessary to have a definite knowledge of the nature of defects to be remedied and their increase with age.

We are aware that repair rates increase with age and that adequate maintenance extends the useful life of pavement. The law of increase with age and effect upon useful life seems to have had no definite engineering acceptance although it is probable that one-third to one-half as much is expended in maintenance as in construction and too often neglected repairs result in entire renewals with economic loss.

Our pavements are of complex elements, each with its own characteristics, and must be so considered in any analysis. First, we have our sub-base or soil as a supporter. Usually in city pavements there are numerous constructions in trenches and at best some of these are made a short time before the pavement is laid. Settlements in these trenches are to be expected to affect the surface of the pavement and require repairs within a few years, altho such may not occur for 25 years or more, as in the rotting of trench sheeting in deep excavation. In general, these should mainly show effects requiring repairs within the first five years of life of pavement. Following this we may expect failures of base due to bad soil conditions, such as springs, etc. and of the surface at certain points due to unusual exposure or use. Running parallel with these two periods will be some minor failures of surface due to improper material or workmanship passing inspection, but these should be very small.

In this consideration an asphalt pavement is assumed because it is most typical of gradual failure and because there are available most data on this kind. Buffalo has kept a complete record of all repair costs on asphalt pavements for upwards of 40 years, covering about 75 million yard-years of maintenance after guarantee on which the yard rate has been kept separately for about 800 different contracts, and figures here given will be taken from such records. Every patch has been located by measurement and plotted to scale.

In such asphalt pavement surface we have two classes of failures, that due to physical displacement and that due to the disintegration of the surface. It really seems that with all our experience and endeavor we should obtain a nearly uniform product, but experience has shown that with two parallel streets laid at the same time by the same contractor and as nearly alike as possible there will be a material variation between the two in maintenance and durability. It may be truthfully said, however, that this condition is common to other kinds of pavements. If it were possible to lay an absolutely uniform asphalt then we should expect under uniform traffic a sudden and almost simultaneous failure of the whole surface. However we do not obtain such results.

An endeavor has been made to reach a determination of the period and rate of increase of repairs from our extensive records, but the variation in annual costs on individual streets is so great that only by averages can any reasonable results be obtained.

Diagram I shows the average annual cost rate of repairs of all our asphalt pavement for each year of age. Thru these points has been drawn a line of fair average, beginning at 4 years and increasing 0.42 cents per year. This line has no significance excepting for general comparison. Bridge floors, alleys, etc. are included.

The danger of relying on averages of dissimilar facts has not been sufficiently appreciated by those who have struggled with this problem. To eliminate these elements so far as possible there have been taken of the Buffalo contracts 306 on streets without car tracks and where the earlier repair costs have been below an arbitrarily chosen amount. These are plotted showing the cost in cents per square yard per year for each year of age and are shown on Diagram II.

Thru these points has been drawn a curve of the form $\frac{N^3}{2100}$, N being the age in years. This shows a close approximation to the actual costs. However there is noted a tendency of certain of the rates to show a slope steeper than the cubic curve. Also there are shown jumps or flattening of the rate increases. To show a probable cause for this there has been drawn a theoretical similar curve, shown in Diagram III, by assuming a series of different streets each having a rate or curve of increase expressed by the cube of the age divided by different constants. On this it is assumed that the various streets have terminated a certain life dependent somewhat on rate of repairs, and the numerical average of the ordinates of these curves has been plotted showing a result most similar to our curve of actual experience.

From this it seems safe to say that the dropping out of various streets as their useful life expires has a tendency to flatten our curve so that the curve of averages is flatter than that of the individual streets.

With this in view and the indications on the diagram that there is a tendency to rise at a rate greater than the cube of the age, a study has been made on the assumption that the repair rate due purely to disintegration of the material increases with the fourth power of the age. This curve is computed as $\frac{N^4}{35000}$. It may be noted there is a tendency of the rates to drop away from the curve near the thirtieth year.

DIAGRAM I

COST OF ASPHALT PAVEMENT REPAIRS ALL STREETS, CITY OF BUFFALO N.Y.

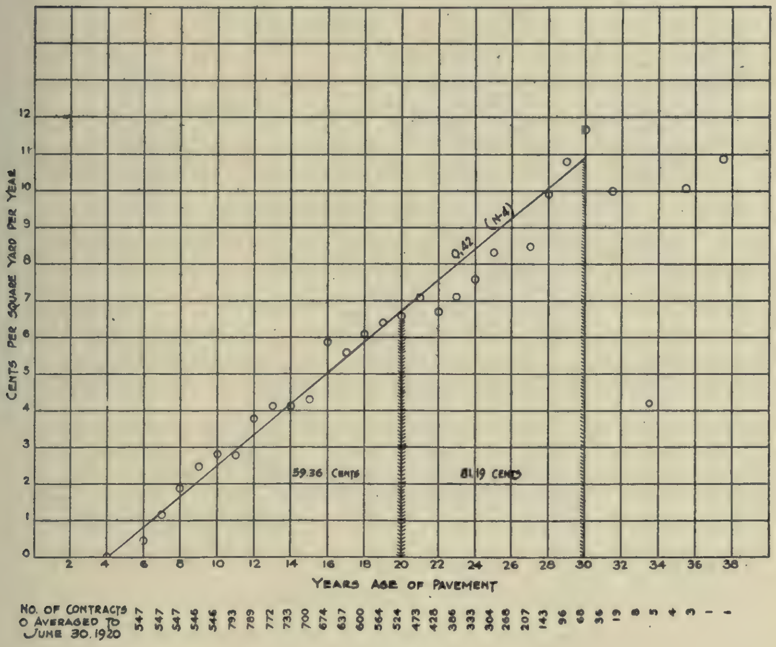
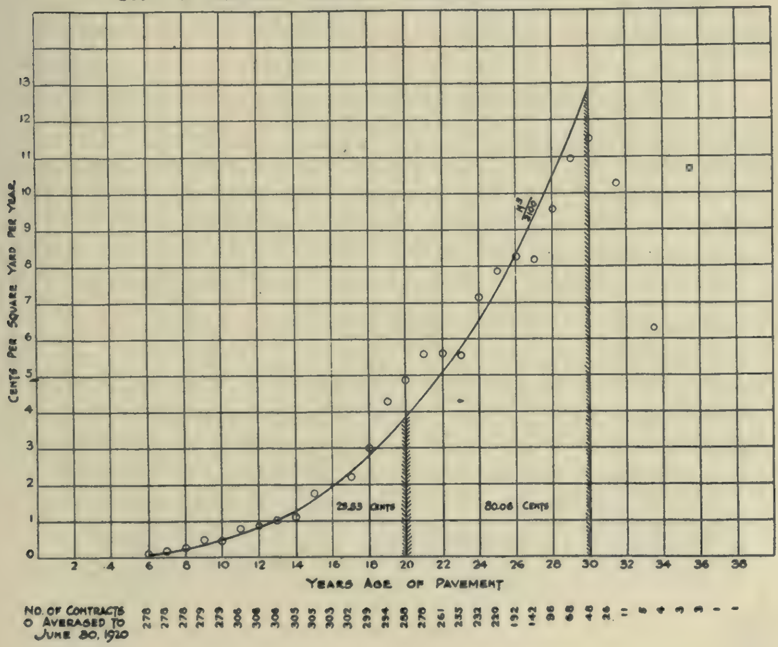


DIAGRAM II

COST OF ASPHALT REPAIRS GOOD STREETS, CITY OF BUFFALO N.Y.



Other assumptions were then made as to formation of this curve. First it was assumed that the basic rate of repairs increased as $\frac{N^4}{35000}$ on the original surface remaining.

Second, that, of the repairs made, one-third went into duplication of patches previously made and two-thirds of the repairs each year replaced an equal amount of the original surface.

Under these assumptions we have a constantly decreasing amount of the original surface remaining to be repaired. The average cost per square yard over the whole period has been not far from $1.11 so that the area of repairs is practically 90% of the costs in cents per square yard.

If a certain amount has been expended to a given age, say 3 cents per yard, one-third has gone into duplicate patches, then 2 cents worth or $2 \times 90\% = 1.8\%$ of the original surface has been replaced and but 98.2% remain to be repaired. If the theoretical rate for the next year by the formula $\frac{N^4}{35000}$ is 4 cents per yard then the amount to be expended will be $4c \times 98.2 = 3.928$ cents instead of 4 cents. This rate of 3.93 added to the previous expenditure then gives a new sum expended to date. With this computation repeated we derive a new curve constantly departing from the theoretical $\frac{N^4}{35000}$. It is readily seen that as the original surface is replaced by patches there will come a time when the deduced rate will cease to increase and, as the original surface is wholly replaced, its repairs cease and the rate becomes 0. The maximum rate would occur at about 30 years and the original surface disappear at 45 years. This deduced curve is shown in Diagram IV.

On this are shown the theoretical $\frac{N^4}{35000}$, the deduced curve of repairs of remaining parts of the original surface, and to this has been added a rate for replacement of the patches, based on the assumption that the two-thirds of the patches laid replacing original surface each year have a life of 20 years, that is, in the 26th year there is added to the ordinate of the deduced curve at 26 years the rate of the same for the 6th year. This gives an interesting curve showing a maximum cost at 30 years, a low point at 40 years and repeating indefinitely.

It may be noted that this curve decreases after 30 years in fair accord with our actual experience, and with that of the City of Washington, the only other city having similar data available. However, in consideration of this curve we must bear in mind the effect of averaging pavements of different characteristics, as shown in Diagram III. No attempt is here made to differentiate these two explanations of rate-curve flattening.

The assumption of 20-year life for the patches has been considered. If the patches last only 5 years then the piling up of the

DIAGRAM III

THEORETICAL CURVES OF COSTS AND CURVE OF AVERAGES

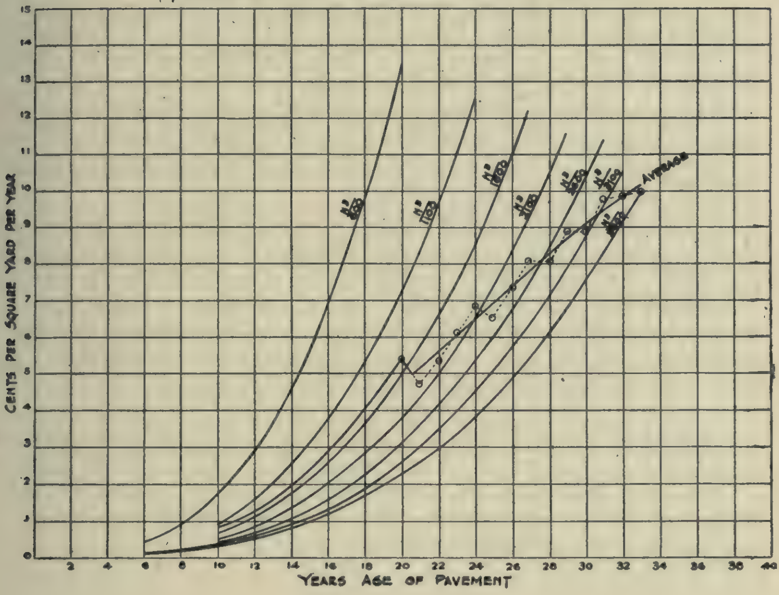
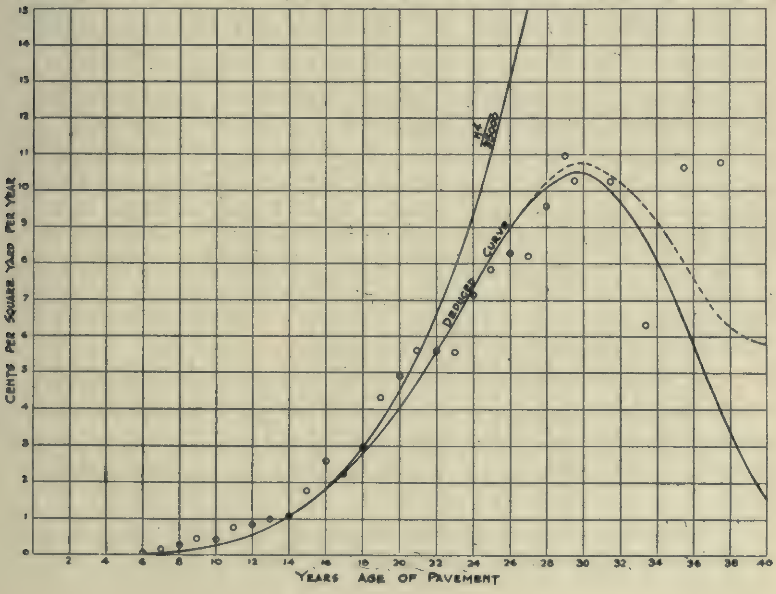


DIAGRAM IV

DEDUCED CURVE OF REPAIR COSTS, 1/3 OF REPAIRS BEING DUPLICATIONS AND PATCHES LASTING 20 YRS



repair rates under the other previous assumptions would be as shown in Diagram V where the ordinates of the curve are added to themselves every 5 years and show a most rapid increase in repair costs reaching 25 cents per yard at the 30th year. A similar study on the assumption that patches are renewed in 10 and 15 years is also shown on Diagram VI.

With these curves before us we make a study of the economic life of a pavement. There has been considerable discussion of the correct theory. The clearest and simplest seems that of H. P. Gillette in his "Cost Data" and such is here used:

"The average first cost plus the average annual repair cost must be a minimum." Or stated differently, the sum of the first cost and total repairs divided by the age must be a minimum. The rule is easily applied in any individual street. If the cost of the top be taken at $1.50 per yard and repairs at end of the 22nd year total 70 cents, then the whole cost has been $1.50 plus 0.70 =$2.20 or 10 cents per year. If, in the 23rd year the repairs will be less than 10 cents per yard then the average for the whole period will be reduced below 10 cents, and the pavement has not reached its economic limit, but if the repairs necessary will exceed 10 cents per yard then the average annual cost of providing the pavement will be increased and the street should be repaved."

Gillette further shows that where the repairs increase in a uniform rate the economic life is reached when the cost of repairs equals the original cost, but that where the repairs increase as the square of the age this limit is reached when one-half the first cost has been spent in repairs.

The above rule must be applied with engineering judgment. If, at a time nearing the economic limit, we find that certain localized causes have made extensive repairs necessary while the remainder of the street is in comparatively good shape, it is possible that an expenditure much exceeding the theoretical may place the pavement in condition where the repair rate for several succeeding years will be low enough to reach another true economic limit after several years. At the opposite we may find the general condition so uniformly poor as not to justify any material expense altho the previous repair rates may have been low.

This rule intelligently applied seems a safe one to follow and an anchor for the engineer who must make the decision, especially when repairs are paid from general taxation but some part of the repaving costs borne by local taxation.

The charter of Buffalo contains an excellent provision to meet this situation and can be safely recommended to those cities without reasonable provisions for such condition:

"All repairs of accepted streets shall be paid from the general fund.

"All streets or part of streets paved at the time this act takes effect, or which shall subsequently be paved, shall be deemed accepted streets within the meaning of this title, and shall be

DIAGRAM V

DEDUCED CURVE OF REPAIR COSTS AND ADDED COST OF RENEWAL OF PATCHES LASTING 5 YEARS

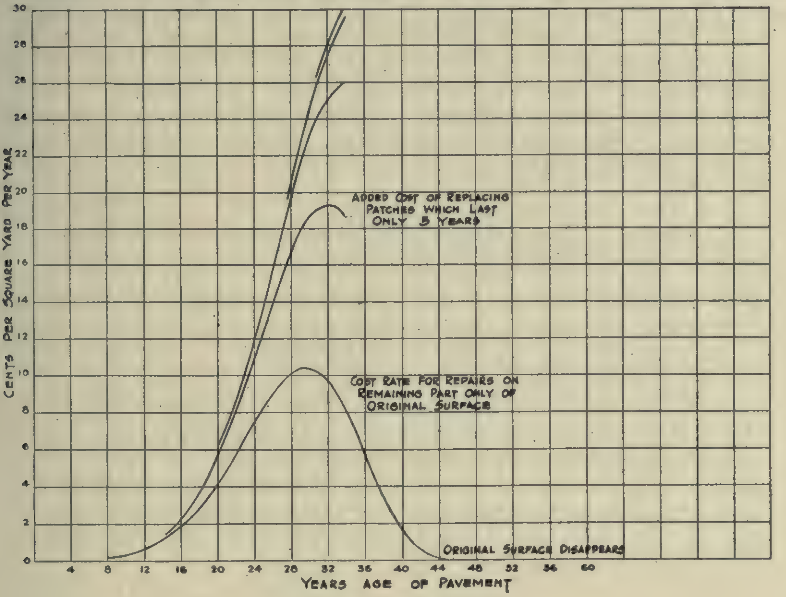
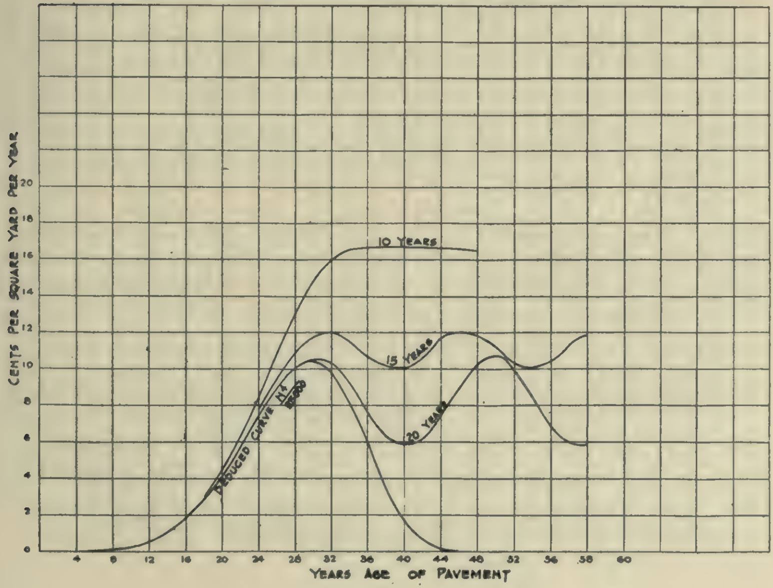


DIAGRAM VI

REPAIR RATE CURVES BASED ON REPAIR OF ORIGINAL SURFACE AND PATCHES RENEWED IN 10, 15 OR 20 YEARS



repaired when necessary, if the superintendent of public works certifies that less than one-third of the carriageway is in condition requiring repairs; but whenever the superintendent shall certify that it is not expedient to make further repairs upon that pavement, in an accepted street or in the portion thereof between two streets that intersect or meet the same, the council may order said street, or portion thereof mentioned in such certificate, repaved, and two-thirds of the expenses thereof shall be paid by local assessment, and the remaining one-third thereof shall be a charge on, and paid out of, the general fund of the city, as provided in this act."

To give us a clearer view of the determination of the economic life some graphic solutions are presented.

In Diagram VII the flat rate depreciation on $1.50, assumed original cost of top, is plotted and above it added the average annual cost of repairs as derived in Diagram V by taking the sum of cost of annual repairs to any age divided by that age. This gives the second curve, having a minimum at 25 years, and at the intersection of this curve with the annual rate curve. Altho the rate curve has a second and equal minimum at 40 years the curve of costs to date divided by age will not have, so there is a decided minimum cost point in a pavement which has had a low repair cost in early years, but a rapidly increasing rate in later years, as might be expected.

The construction of this curve for consideration of an individual street is interesting. While the annual expenditures may show a wide variation the total of all expenses to each particular age divided by that age will give a fairly uniform curve.

Some consideration of the effect of different durability of patches has been given in the preceding diagrams. The economic aspect may be studied from this Diagram VII. Above the curve of average annual costs on basis of the assumption that repairs last 20 years, has been plotted a similar curve derived from curve shown on Diagram V, where patches last 5 years only. This curve is intersected by the annual rate curve for a minimum cost at 22 years.

The average annual cost on the 20-year patch curve is 8.09 cents and on the 5-year curve 8.68 cents, so for 22 years life the pavement has cost $(8.68-8.09) \times 22$ or 12.98 cents more. The total cost on the 5-year curve is 32.29 so to make the average annual cost the same the patches should be laid for $32.29-12.98=19.31$ cents. It would be necessary to lay the 5-year patches for $19.31 \div 32.29$ or 60% of the cost of the more durable patches. This might be possible if we were sure the individual pavement would not otherwise much exceed 22 years life, but if it should be a pavement which might, with good repair, reach a greater age, then repairs would have to be made at even a lower per cent of the assumed rate of cost of good repair. The problem is one calling for sound engineering study.

DIAGRAM VII

ECONOMIC LIFE OF PAVEMENT BASED ON $1.50 COST OF TOP AND PATCHES LASTING 5 YRS. AND 20 YRS.

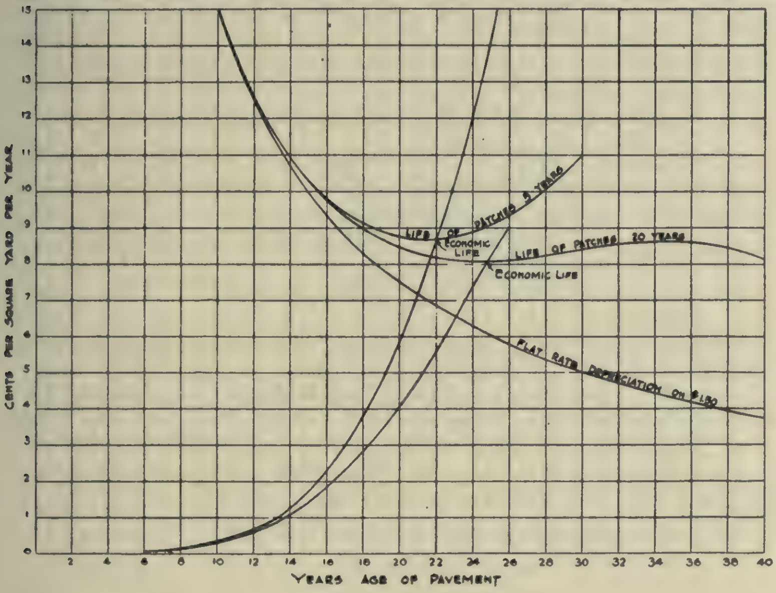
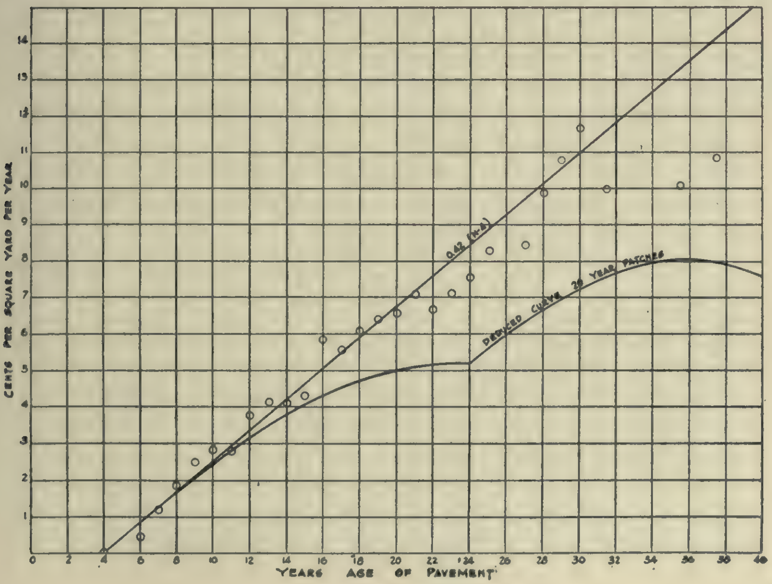


DIAGRAM VIII

FOR AVERAGE OF ALL PAVEMENTS DEDUCED CURVE OF REPAIR COSTS BASED ON 0.42 (N-4)



The studies so far presented are on the better pavements. For the poorer or average ones deduced curves of similar construction have been plotted for the straight line shown on Diagram I, $0.42(N-4)$ Diagram VIII, which shows the improbability of repairs increasing on any straight line formula and for the curve $\frac{N^2}{40}$ in Diagram IX which shows a closer approximation to our actual experience but yet indicating that the actual surface deterioration probably exceeds a curve of the second degree and probably that of the third power of the age.

For the purpose of comparison the average annual cost curves of the assumptions of increase with age $0.42(N-4)$, $\frac{N^2}{40}$ and $\frac{N^4}{35000}$ have been plotted in Diagram X. The results are somewhat surprising in showing that where repairs do not increase rapidly with the age of the pavement and enduring repairs are made there is no marked point of minimum cost. It may be best assumed from this that the lower powered cost curves are not applicable to individual streets for the reason explained with Diagram III and our actual depreciation curve is of a higher power.

However, we know from experience that the definite limit is hard to draw in cases of pavements which have reached an age of over 30 years. If we accept the assumptions advanced of the gradual replacement of the surface by long service repairs we may in certain streets expect an indefinite economic life. Of course there are other elements which will govern. The original surface will wear thin and repairs cannot be made materially thicker without creating undesirable bumps. The surface, by repeated repairs, will become uneven and modern traffic conditions demand a smoother one.

That other results obtained in computing the previously mentioned diagrams may be available there are plotted, in Diagram XI, curves showing the per cent of original pavement remaining at various years and the curve of total costs to date for the various years for the two curves $\frac{N^2}{40}$ and $\frac{N^4}{35000}$ with patches lasting 20 years. These curves show that, for an economic life of 25 years, on the latter curve there remain about 68% of the original surface and the cost has been about 53 cents per square yard. It may be noted from the percent of remaining surface curve that the rate of disappearance between 25 and 75% of the surface is practically a constant one or a straight line.

These straight line portions extended, as shown in the dotted lines to the two limits, may be given a significance as indicating roughly the real period of disintegration of the surface.

DIAGRAM IX

FOR AVERAGE OF ALL PAVEMENTS. DEDUCED CURVE OF REPAIR COSTS BASED ON $\frac{N^2}{40}$

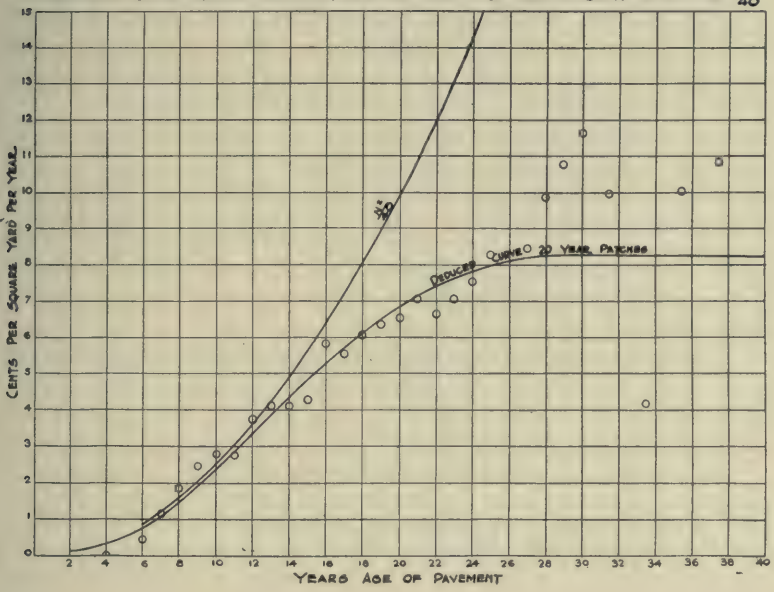
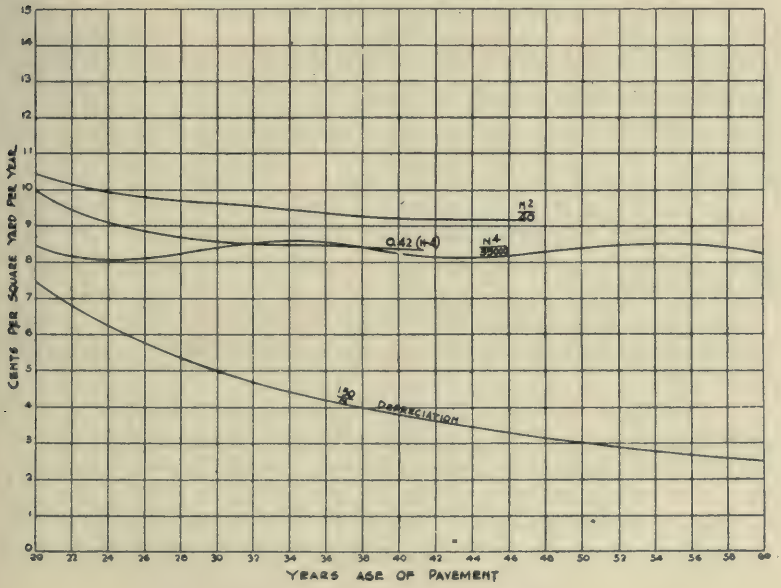


DIAGRAM X

ECONOMIC LIFE FROM THREE CURVES



On the curve $\frac{N^2}{40}$, or what we may call the poorer streets of high repair costs in early years, the disintegration might be assumed to begin at 12 years and be complete at 35 years, while with the better streets having a rate of repair of $\frac{N^4}{35000}$ the same would occur between 20 and 36 years. These assumptions do not seem unreasonable from experience altho we know that the surface does not entirely disintegrate in 36 years. This assumption would lead to another, that the early repairs are due to mechanical causes and minor defects of mixture and workmanship. This does not fortify any arguments for shortened periods of guaranty maintenance if such are obtained at a reasonable cost.

The curve based on the cube of the age has not been computed as it is assumed to lie between those given and that the latter fairly represents the normal variation which should be expected under the various assumptions made.

As a check on the values shown for remaining portions of a pavement, one block of a pavement 32 years old was taken and all repairs combined into one plot as shown in Diagram XII. This is a heavy traffic street. The remaining surface is 26.4% compared with a theoretical value of 28% as shown for good streets in Diagram XI.

DISCUSSION

GEORGE H. NORTON: When the article was prepared it was with full knowledge that there had been advanced several divergent views as to the determination of the economical life of a pavement and it was intended to but lay a foundation for full discussion.

Copies of the article were sent to some who had been interested in this subject and enough views have been expressed to warrant some preliminary discussion even before formal presentation at the convention.

H. P. Gillette, Editor of *Engineering and Contracting*, informs me he has found error in the formula quoted and that the correct solution is

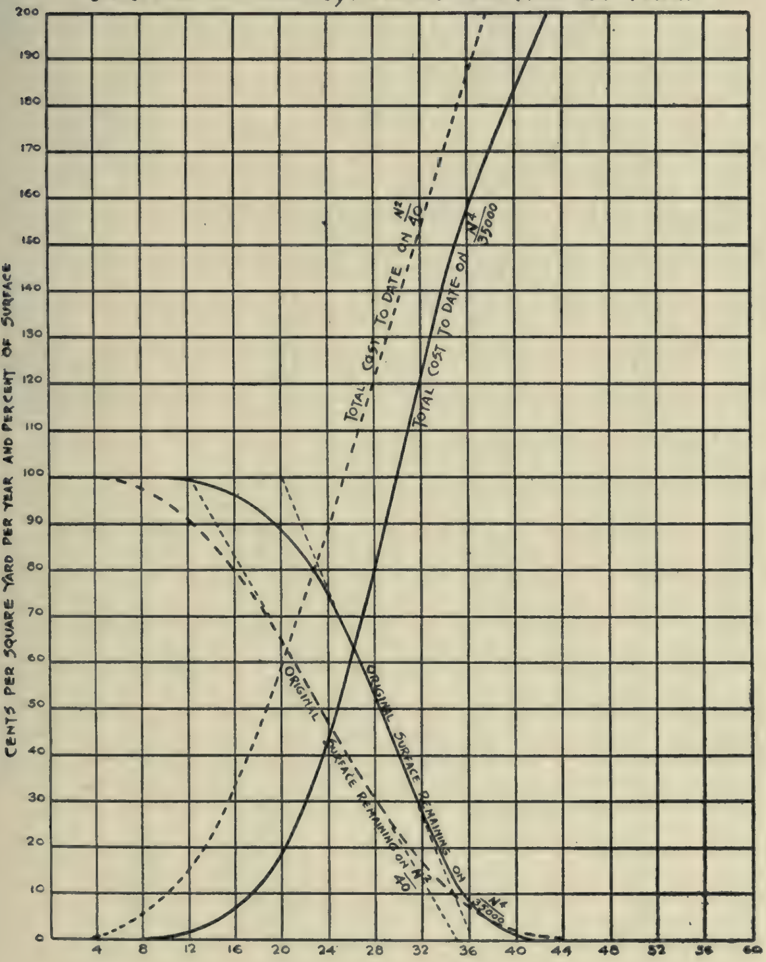
"The time to repave an old highway is reached when the annual upkeep cost of pavement and vehicles is greater for the old highway than is the corresponding cost for the new highway plus the annual interest charge on the new pavement."

Our honored member, Mr. Geo. W. Tillson also says this solution as formerly presented by Mr. Gillette and quoted in the article does not meet his approval. It is assumed he yet holds the views once expressed by him and quoted below.

That the divergent views may be brought clearly before you this preliminary discussion is submitted.

DIAGRAM XI

TOTAL COST OF REPAIRS TO DATE AND PER CENT OF SURFACE REMAINING, PATCHES LASTING 20 YEARS



It seems agreed that a street should be repaved when some definite relation between costs of repairs and a function of the cost of service of the pavement is reached.

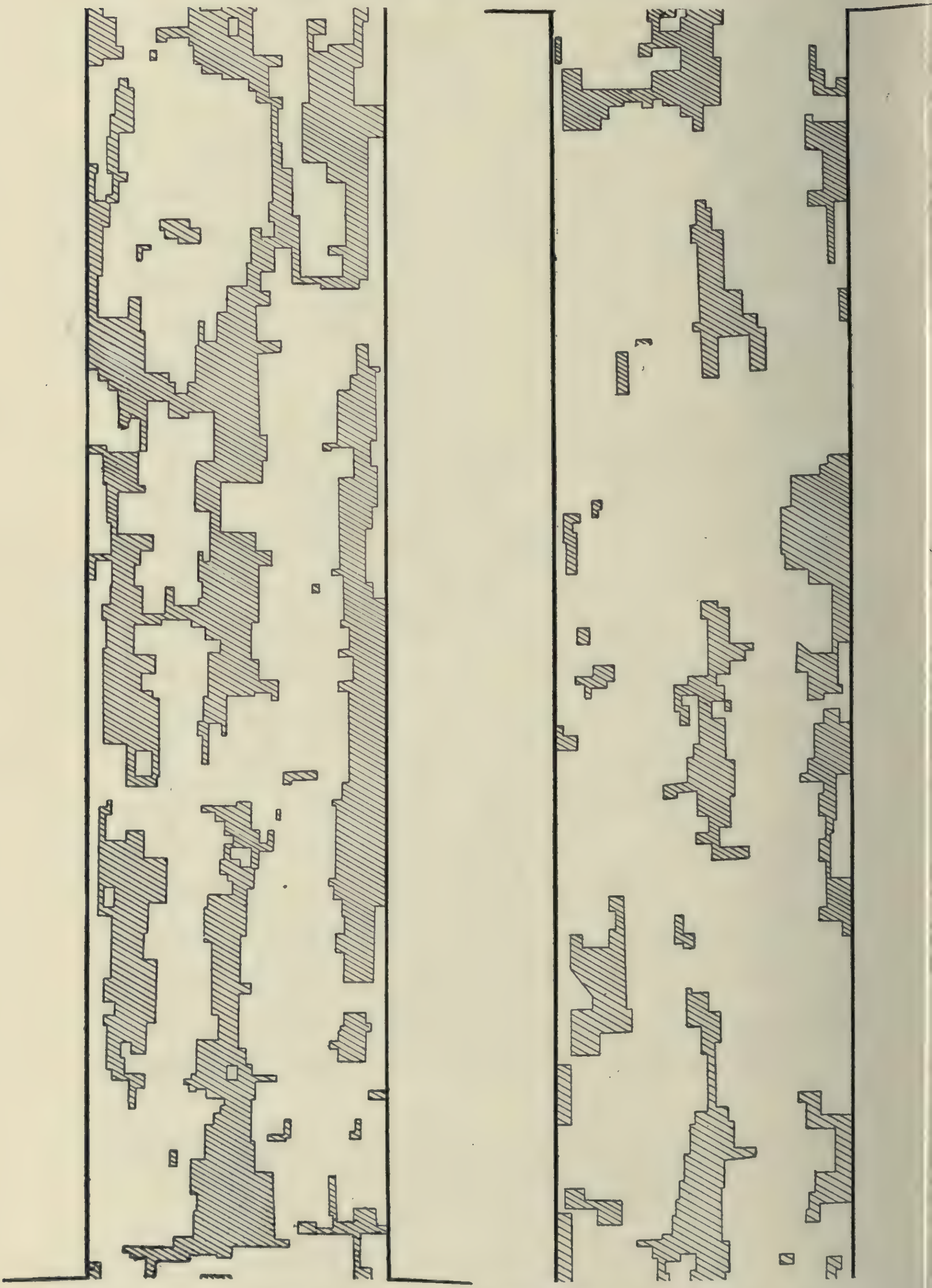


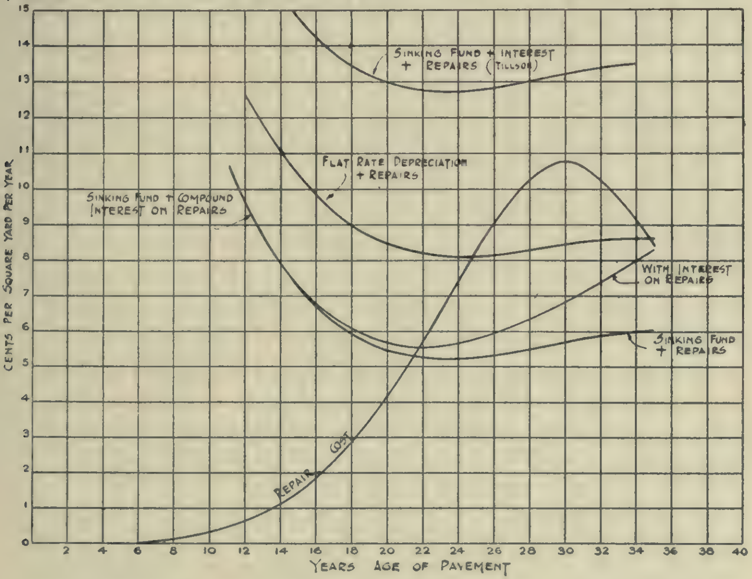
Diagram XII—*Showing Area Actually Repaired on one Street Block in 32 Years*

The following forms have been studied showing that when the cost of repairs equals or exceed a certain basis the pavement has reached its economical life.

(1) Mr. Tillson; sum of	(Interest on First cost: Sinking fund annual payments to renew at end of life: Average annual cost of repairs.
(2) Mr. Gillett; (first theory) sum of	(Flat rate annual depreciation: Average annual cost of repairs.
(3) Mr. Gillette; (second theory) sum of	(Interest on first cost: Extra cost of vehicle repairs on old pavement compared with new.
(4) Sum of	(Sinking fund annual payments to renew at end of life: Average annual cost of repairs.
(5) Sum of	(Sinking fund annual payments to renew at end of life: Average annual cost of repairs: Compound interest on repair costs to end of life.

DIAGRAM XIII

VARIOUS DETERMINATIONS OF ECONOMIC LIFE OF PAVEMENT. DEDUCED CURVE · COST OF REPAIRS



For a basis of discussion to clear our minds it is assumed that the correct theoretical method would be to pay for a pavement in equal annual instalments during the life of the pavement, as it renders service and to repeat with a new pavement. Interest for all computations has been assumed at 5%.

That the results may be more readily studied the different theories have been worked out and plotted as curves showing costs with different life limits and the minimum cost or economical life showing as the low point of the cost curves, Diagram XIII.

The simplest assumption involving interest allowance is that the original cost of pavement is met by issuing sinking fund bonds for the life of the pavement. Assume the life of the pavement at 20 years or 4.54 cents per yard to be paid in each year. At the end of the 20 years the bonds are retired and new ones issued for a new pavement. The interest charge on the cost of construction is therefore a constant and independent of the life of the pavement, and enduring so long as any pavement is provided, with no relation to the life of the pavement. However, the sinking fund payment to retire the bonds is a variable dependent upon the life of the pavement. If we say we do not pay in that way but by cash in advance, the case is not different if full interest allowance is made. The cost on the sinking fund basis for 20 years is 4.54 cents to retire bonds plus 5% annual interest on $1.50, 7.5 cents per yard year, total 12.04 cts.

If payment is made in cash in advance, $1.50, we should charge ourselves with what this $1.50, in advance, would produce, at compound interest, to meet 20 equal annual payments and, by annuity tables, we find that present worth ($1.50) will purchase 20 equal annual payments for a period of 20 years of 12.04 cents, or the same as the total charges under the sinking fund method.

For illustration, the curve of annual cost of repairs on $\frac{N^4}{35000}$, patches lasting 20 years, has been used, taking the total cost to each date divided by the age and to this adding the sinking fund requirements for $1.50 for various ages, plotted as the lower curve on Diagram XIII. It, however, does not seem consistent to make interest allowances on construction costs unless the same is done with repairs.

Compound interest has been computed on cost of repairs to date, divided by age, and added to this cost curve.

The flat-rate depreciation plus average annual cost of repairs is plotted above this. Mr. Tillson's recommendation, adding the interest on cost of original construction to sinking fund plus average annual repair costs amounts to adding 5% on $1.50, or 7.5 cents to the lowest curve and is shown as the highest curve.

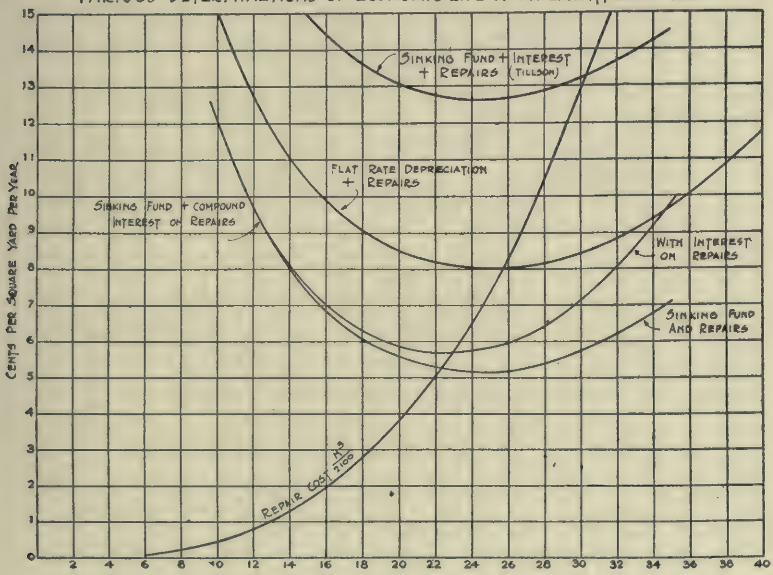
Mr. Gillette's curve has not been plotted, but would be a horizontal line at 7.5 cents interest charge plus any added cost of repairs to vehicles. These curves show a wide variation in allowable limit of repair expenditures and cannot all be correct. As they are all complicated to a small extent by being based on the annual repair costs as modified by assumed life of patches they have also been computed on a simple curve of increase of cost of repairs, $\frac{N^2}{2100}$, without any allowance for replacement by repair and shown in Diagram XIV showing most similar results.

It is not intended to make any argument in favor of the correctness of any of these rules, but there appear certain fundamental defects in some of them as arguing against their general acceptance.

If we assume the sinking fund theory for disposing of our initial costs, then when one pavement is paid for and a new one laid the interest charge becomes a constant existing so long as successive pavements are provided and cannot be a factor in determining the economic life as such, altho it may possibly affect the allowable extent of repairs and thus the life extent.

DIAGRAM XIV

VARIOUS DETERMINATIONS OF ECONOMIC LIFE OF PAVEMENT, CURVE $\frac{n^3}{2100}$



On these diagrams has also been shown the curve of increase in cost of repairs. It should be noted that this curve intersects two of the cost curves at their minimum, but not the others. In theory the minimum cost point must be at the intersection of the repair rate curve.

An analysis of the factors in detail will fully substantiate this, but such is here omitted. We have started out to find the allowable expenditure for repair and have various members for the other end of the equation. The solution can only be found where the rate of repair equals the minimum cost of providing and maintaining the pavement. Where represented by curves plotted from values the minimum cost must occur at the intersection of the repair rate curve or the conditions of the equation of our problem are not met.

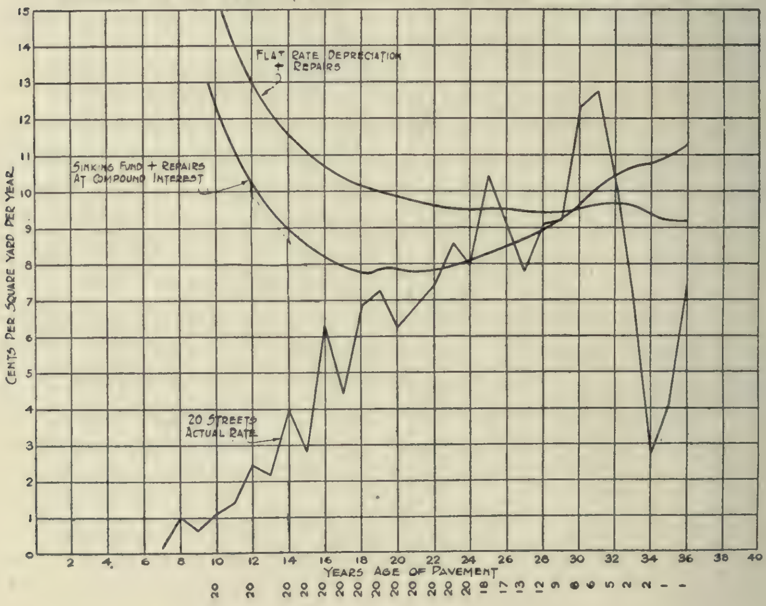
Mr. Gillette's new theory might or might not produce an intersection depending upon values assumed for "repairs to vehicles" which might be better stated as a factor of accommodation to traffic.

Two curves of cost meet the above conditions; flat-rate depreciation and the sinking fund plus interest on repairs. However they give widely different allowable expenditures at their respective low points.

No attempt is here made to argue between these two curves for acceptance. Theoretically they both seem reasonable.

DIAGRAM XV

AVERAGE OF 20 STREETS CONDEMNED IN 1920-21, AVERAGE AGE 29.5 YEARS



To show what light the Buffalo experience might have on this point of difference the record was taken of the last 20 streets, without car tracks, which were certified for further repairs. The determination is made by Mr. Vandewater, member of this Committee, based on long experience and sound judgment. It was somewhat surprising to find that these 20 pavements had an average age at condemnation of 29.5 years, rather above the average, ranging from 25 to 36 years. The actual repair costs at the high-priced level of the past two years was proportioned down to the average taken in construction of the previous curves, but no adjustment made on costs in 1918 or previous years, so the rates would show somewhat above the average of our whole experience, and further, the streets were not separated by low early cost of repairs as was done between Diagrams I and II, so the average annual repair costs are somewhat above those worked out on basis of $\frac{N^4}{35000}$ or $\frac{N^3}{2100}$. These values have been worked out for the rate curve of these 20 streets with a flat-rate-depreciation cost curve which show a minimum value of cost curve and intersection with the rate curve at 30 years compared with 29.5 years actual for sound judgment, Diagram XV.

Curiously enough this also occurs nearly at the intersection of the "Sinking fund and interest on repairs" curve but much beyond its minimum.

This coincidence of our judgment with the flat-rate depreciation plus average annual cost of repairs curve forms the basis of the remark in the article that the flat-rate depreciation method seemed a reasonable one when such was used in the construction of a number of the diagrams.

Certainly the accommodation for traffic should be taken into consideration, but it may be much better as an independent factor after some other basis is established.

MR. HOWARD: That is merely the asphalt portion?

MR. NORTON: Yes.

MR. TILLSON: This is a subject of much importance, and one that has received comparatively very little attention. For the last ten or eleven years I have been so engaged that I have not kept up with this work in detail, but I went into it quite extensively twelve or fifteen years ago. I hate very much to disagree with any theory that Captain Norton advances or with anything that has been deduced from the Buffalo records, because I know how good they are and how good his judgment is, but I must differ to a certain extent. I found in making my studies that it was almost impossible at that time to find any direct ratio as to the cost of repairs and the age of the pavement. A pavement may require a great deal of repairs this year, and you may spend five or ten cents a yard and put it in such repair that it will go two or three years more without doing anything because it has been put in such good condition. Of course, that is overcome to a certain extent when you have the great number of repairs that they have in Buffalo. Then too, the way the records were kept some twelve or fifteen years ago showed simply the amount of money that had actually been spent on the pavements, not what was required to be spent.

Now as to the determination of the economical time to repave, which is the only point upon which the Captain and I disagree, I would say my figures were based on this supposition, for instance, in New York City, where all repaving work is done with money raised by a bond issue but the repairs were made out of a general fund created by a direct tax. The Captain figures the cost of the payment per year as the original cost plus the total cost of repairs, divided by the age of the pavement. If you are paying for a pavement by the bond method, when your pavement is out of repair to such an extent that it must be repaved you have got to have another bond issue to repave it.

My idea is this: You should take for the cost of the pavement the amount necessary to create a sinking fund that will equal the cost of the new pavement when the time comes that the old pavement is worn out. Supposing a pavement will last twenty years and it will cost $2.50 when it is laid. Then your sinking fund must be a sufficient sum to provide $2.50 at the end of that twenty years. Not necessarily either the exact $2.50 because the second pavement will not cost as much as the first because you have the foundation already in. That is the money it will take to create the sinking fund. That is the money the city has actually got to raise. Then there is the interest on the $2.50 a yard bond issue. The city has got to pay that. Then there is the cost of repairs, so there is the money that has actually been paid by the city for interest on the cost of the pavement, so much for sinking fund and so much for repairs. The only weak point in the argument is the compound interest on the cost of repairs. We don't know the life of a pavement or how long it will last. It does not seem to me that the cost of the interest on the repairs is very vital. You have got to use good sense and good judgment with this. Your pavement may cost you 3c for repairs one year and 15c the next year, or vice versa, but by finding out what a pavement has cost in repairs for a series of years an engineer, by using his judgment, can tell whether that is the proper time to repave the street. The city must pay a specified sum as interest and also for the sinking fund. These two amounts are fixed. The cost of repairs is uncertain. So if this cost is 20c a yard and that of your sinking fund, etc., is 15c, and the repair cost exceeds the interest and sinking fund cost the pavement should be relaid; but if it is the other way and it is only 10c or only 7c it is foolish to relay it, except, and here is where your common sense comes in again, if your amount of repairs is so much that you are keeping the street torn up a great deal, then it is an interference with business and that must always be taken into consideration. I don't see how you are going to get away from that because that is the actual money that must be paid out and when the pavement has worn out, the bonds are due, the money is there to pay for the bonds, and a new set can be issued and taken care of as before. That is based on the proposition that you sell the bonds for the same length of time that the pavement is supposed to last. If you expect the pavement to last 20 years and sell the bonds for that time and when the 20 years expire the pavement is in good condition, then the rest of your pavement life you are on velvet; if it expires in 15 years instead of twenty, then for 5 years you are paying a sinking fund on two issues.

MR. HUBBARD: Are these rock asphalt pavements or sheet?

MR. NORTON: There is a considerable amount of Kentucky rock asphalt, sweetened with a little of the German rock. It ran only 7% bitumen and was sweetened with the European rock. The rest is mostly Trinidad.

One reason why I can't accept Mr. Tillson's determination is because the allowable rate of repairs is beyond anything we think is possible, and we are rather liberal with our repairs. We have never paid for pavements in Buffalo with a bond issue. The repairs are from the general fund, the repaving one-third general charge and two-thirds open assessment, which makes it necessary for us to have a rule for drawing the line on the extent of repairs.

As to the theoretical side of including the interest cost, I agree that it is a part of the cost of the pavement, but on a sinking fund theory, if we retire our bonds at the end of a certain time, the interest ceases on the bonds. We immediately issue a new series and the interest starts again. The interest charge thus becomes a constant factor during the life of all the pavements that had been laid on the street. It is not a factor that would enter into a determination of that kind because it is a constant factor and carries your cost rather high.

The other theory put out, the straight line depreciation, was advanced by H. P. Gillette of Engineering and Contracting, of Chicago. He criticised Mr. Tillson's theory quite markedly, and said the determination of the economic life should be the interest on the cost of the pavement plus the additional cost of vehicle repairs on the old pavement as compared with the new one. I think that is worse than anything else that has been advanced. I would not say in public as I have to Mr. Gillette in writing that I think his second thought is worse than his first one.

MR. HOWARD: Twenty-two years ago I was employed to accompany the road pavement engineer of Berlin thru the principal cities of the United States to see what was good for use in that large European city. We first investigated New York and found they were repaving Broadway with granite block pavement, with the old concrete base still there. We found it was being paid for by a bond issue. He held up his hands in horror and said the wearing surface of the pavement or any portion thereof should be charged to maintenance and not to a bond issue, and should be paid for from current taxation. Some years later I investigated an investment of $16,000,000 in Connecticut on bond issues. That $16,000,000 worth of highways in Connecticut had been constructed and maintained continuously in constant good repair.

Those highways had been maintained from current taxation and the entire invested bond issue was there at the end of the bonded term. There is an example in America of the entire bond issue conserved in its entire value by the maintenance of the surface by constant attention with funds from current taxation. We have come in the United States to a stage where economical constant maintenance is an important problem.

REFINING OF ROAD OILS AND ASPHALTS FROM CRUDE PETROLEUM

Contribution from the Standard Oil Company (New Jersey)

Presented by Herbert Spencer

Prior to the introduction of the Mexican asphaltic base oils the residue from the distillation of the Kansas-Oklahoma crude oil furnished the asphalt required for road work; likewise the residues from the Texas and Illinois crude oils were extensively used for this purpose. The yields from these grades, however, were small in comparison with the demand for asphalt products and while various methods were being developed to increase the yield, the situation was materially relieved about 1912 by the opening of the Mexican fields, which yielded an ideal material for the production of asphalts, asphaltic oils and similar products.

To simplify the understanding of asphaltic products they may be assumed to be a more or less homogeneous solution of two general classes of compounds: liquid oils, which are completely volatilized when sufficient heat is applied and solid, brittle asphalts, resembling Gilsonite, which, when heated, are only in part volatilized, leaving a residuum of coke or carbon.

To go into the question of refining in detail, it is the practice to carry on the distillation in stills of the ordinary type, preferably with large outlets and large condenser pipes; this to accommodate a large amount of steam and thereby insure an asphalt free from decomposition products as well as to hasten the process of manufacture.

The stills commonly employed are of the horizontal cylindrical type, about 45 feet long and 14 feet in diameter. They hold a charge of approximately 800 40-gallon barrels of crude oil. The still is usually provided with two steam-spray pipes, running the length of the still and close to the bottom, each pipe being perforated with 1/16 holes and drilled in such a way that the steam is directed toward the bottom at an angle of 45 degrees from the radius of the still shell. These holes are located about 8 inches apart and are staggered in such a manner that they alternately direct the stream on opposite sides of the radius of the still.

The upper part of the still carries a dome to minimize carrying over of residuum mechanically, and this dome is connected directly with a condenser with one or more 12-inch pipes. These pipes are manifolded in the condenser in such manner as to take care of a large volume of steam.

A still thus charged with Mexican crude is warmed by means of a suitable fire until the temperature of the crude reaches approximately 350° F. At this point the water has all been removed, together with a small amount of distillate oil, from which the naptha and kerosene are subsequently recovered. At this point superheated steam is introduced into the spray pipes already described, which immediately starts a flow of vapor from the body of the crude on account of its reducing of the partial pressure. The oil vapors pass over with the steam to the condenser, where both are converted to liquids and flow on to suitable receiving tanks where they are further taken care of as desired.

The steam reduction process is continued with increasing temperature until the residue in the still has the desired characteristics. Fo example: If a flux oil is required, the distillation process is arrested when the flash point of the residuum reaches 375° F. If a road binder for penetration work is required, the still is arrested when its contents has a penetration of 110 to 140, according to individual preference.

It will be evident that as the process advances the residuum becomes harder and that any desired consistency can be produced. To avoid decomposition the still temperature should not exceed 675° F. to 700° F.

A great variety of specifications confront the manufacturer, but after he has once examined them and determined whether his process and crude material will manufacture the desired product, he usually finds that one or two tests, together with his knowledge of what has been done to the crude oil in process, is sufficient to assure him that the material will fall in line and meet all specifications. For example: In making a paving asphalt of say 50 penetration, the manufacturer might be held to a dozen tests, but he learns by experiment that if he runs the still to the range of penetration required in the specifications, all other requirements are met. He thus adopts a working specification covering penetration only, and material is only submitted to the laboratory after it has been drawn from the still and is ready for shipment for final approval.

Air Blowing Process

Thus far, only the straight concentration process has been dealt with. An objection to asphalt produced by the latter process is that when a suitable penetration has been obtained for normal temperatures, the consistencies at winter temperature and extreme summer temperature, are harder and softer respectively than desired. Unfortunately, the application of means for remedying this feature, adversely affects other desirable properties. For example: When material has been processed so as to temper it for extreme summer and winter temperatures, the ductility is considerably affected and the melting point materially increased so that what has been gained in bringing the properties of materials nearer to those of rubber, with respect to temperature susceptibility, has been lost in strength of the material.

For some purposes, such as joint fillers and certain roofing and other water-proofing materials, the importance of non-susceptibility to temperature changes far outweighs the other characteristics which must be sacrificed, and consequently calls for a modified process. Several means have been proposed to effect the changes under consideration, but the only one of commercial importance is the so-called blowing process. In a few words, it consists of subjecting a liquid or semi-solid petroleum or residuum to the chemical action of air at elevated temperatures.

In large scale operation, the process is carried out in various ways. An open vertical cylinder may be used and air introduced in sufficient volume so that the heat of the reaction is sufficient to maintain the required blowing temperature.

Horizontal stills, similar to those employed for distillation of crude oil, are successfully used either with or without a condenser air being introduced thru the steam pipe in place of steam.

In case no condenser is used, a pipe of light iron connects the dome of the still with a stack at sufficient distance to prevent the small amount of volatile oils which are carried over from ignition from contact with the still fires. Frequently, condensers are employed in order to recover all of the light oils which may be produced. It will thus be seen that 800 40-gallon barrels of a residuum may be charged in a crude still, as described above, and subjected to the air-blowing process. In order to get the full effects of blowing, or oxidation, it is necessary to operate on a liquid residuum, thus causing the final product to owe its hardness, in the greatest degree, to asphalt formed by oxidation rather than the natural asphalt originally contained. It will be observed that by this means the residuum operated upon must still contain some of the more volatile oils and consequently a product made in this manner inclines to a low flash point and, therefore, shows more volatile matter than a product of similar hardness made by straight concentration.

It will further be observed that in working for a highly oxidized product, a low blowing temperature must also be used in order that the light oils be retained in the residuum and not be carried off with the waste gaseous products.

It then follows that by blowing a liquid residuum at low temperatures, an elastic product is formed, which is comparatively non-susceptible to temperature changes, but is lacking in ductility and strength, and further would show considerable volatile matter under moderate heat. It will be seen from the above that by modifying the amount of steam reduction before the blowing process is started, and the blowing temperature, quite a number of products possessing varying characteristics are at the disposal of the manufacturer.

Tests

The significant tests to which importance is attached in connection with asphaltic road materials, and which have a real bearing on the quality of material in service are the following:

Penetration
Melting point
Solubility in carbon disulphide
Bitumen soluble in carbon tetrachloride
Loss at 325 ° F.
Penetration of residue
Specific gravity
Ductility

Penetration—First of all, a measure of consistency is all important. With road binders, paving asphalts and intermediate products, penetration is the universally adopted measure of consistency.

Melting point—Melting point is a test usually called for in connection with the hard asphalts, as it has some significance as to the fluidity of the product at application temperatures and stability in hot weather. Inasmuch, however, as paving and road making materials are scarcely ever treated in a manner to raise the melting point, this test is of doubtful importance because material on the market, almost without exception, has the minimum melting point which can be secured by any method of manufacture.

Solubility in Carbon Disulphide—This is taken as an indication of purity. As a rule all asphaltic products of petroleum origin, prepared artificially, are very pure, running as high as 99.5%, or even more, soluble in carbon disulphide, leaving 0.5% or less as insoluble.

With the asphalts prepared by fluxing native asphalt with petroleum fluxes, the result is different. Fluxed Trinidad asphalt, for example, may show as high as 35% insoluble, and in case of fluxed Bermudez from 2 to 5% is not uncommon.

Solubility in Carbon Tetrachloride—The amount soluble in carbon tetrachloride, when compared with solubility in carbon disulphide, is taken as an indication of decomposition products. It is mainly used as a guide to indicate whether still temperatures have been too high and whether an insufficient amount of steam has been used, in manufacture of product, to bring about sufficient agitation to prevent local overheating of the material next to the shell of the still.

The manufacturing processes are so well understood at the present time that any appreciable difference between the bitumen soluble in carbon tetrachloride and that soluble in carbon disulphide is rarely found. In former years, when fluxes were made, to be used in connection with native asphalts, fire reduction was very often employed, resulting in partial decomposition, which was reported to have shown up adversely in the pavement. In all probability this is the origin of the test employing carbon tetrachloride.

Loss at 325° F. and Penetration of Residue—This furnishes an indication of how permanent the material would be when the finished pavement has been subjected to weather conditions. A native or other hard asphalt softened with a volatile flux would show a high volatile loss and a low penetration of the residue, while if a comparatively non-volatile flux were used, or in case of a straight petroleum asphalt, the volatile matter would be low and the penetration of residue not excessively less than the penetration of the original material. There is always a reduction in penetration after heating varying from 25 to 33%, which, no doubt, arises from oxidation of material during test. This applies even to material which shows no loss at 325° F. This test also has a value in connection with so-called cut-backs, which are employed as a means of entering the asphalt into the road mixture, depending upon the subsequent seasoning of the pavement for the evaporation of the solvent and consequent hardening of the bitumen. Cut-backs are often specified, based on a reduced asphaltic petroleum crude, and limitations are given as to percentage volatilized at 325° F. and character of the residue. While this is all very well for the user, it is usually a difficult specification for the manufacturer, in that a uniform application of the volatility test is almost an impossibility. This remark applies only to a reduced crude where there is no sharp demarcation between the volatile oil and the asphaltic base. Therefore, when a manufacturer is confronted with a specification of this kind, it is often necessary for him to adopt the safe course and manufacture the cut-back from a prepared base, meeting the requirements called for in the residue after heating to 325° F., and then cutting this base back with a moderately light petroleum oil which he knows will all volatilize at 325° F. This procedure is undesirable for economic reasons.

Specific Gravity—Intrinsically, specific gravity is of little or no importance as a guide to the quality of the material. It furnishes, however, quite a little information as to the source of the material and mode of preparation, especially when taken in connection with other tests; thus a road binder prepared from Illinois crude might be slightly below unity in specific gravity while a product of the same consistency from Mexican crude would show above unity. It will thus be seen that specific gravity is of more value as an indication of origin than as an indication of quality.

Ductility—This is taken as an indication of the ability of the asphalt to cement road material together. That which strings out without breaking when pulled apart will bind the mineral constituents of the road well and make them adhere; also there is less liability to fracture, and, should fracture occur, surface will re-unite.

Mexican crude petroleum yields a very ductile material when straight steam reduction process is employed. With proper care there is no difficulty in securing ductility of 100 centimeters or more. Some manufacturers, however, insist that 100 centimeters is too high and recommend an intermediate figure, as an indication of less susceptibility of the asphalt to temperature changes. This might be secured in various ways; one way would be by limited air blowing. A paving asphalt could be prepared first by steam reduction of the crude to about 100 to 200 penetration and then finishing the hardening to 50 penetration by means of the air blowing process. As already stated above, this would yield a material which would not harden so much at winter temperature, nor soften so much at summer temperature as a straight reduced asphalt. A natural consequence of such procedure is lessening of the ductility. It is questionable whether what is gained by this procedure is more than offset by the loss in other valuable properties. It may be that the prime motive of such procedure is to increase the yield of asphalt from the crude petroleum.

Among the specifications which the manufacturer is obliged to meet are found a number of tests, in addition to those already discussed, which have no particular bearing on the quality of the material, and often do not permit of the accuracy implied by the limitations called for. These may have been introduced thru ignorance or design. Asphalts of undisputed value may be obtained from several sources, but they will differ in various characteristics which have no bearing on their real worth. Among these are

Fixed carbon,
Solubility, particularly in light naptha,
Paraffine scale.

To this might be added asphalt content, altho it must be admitted that this latter would have an important value if a method was devised for quickly and accurately determining it in all classes of material.

Fixed carbon—Fixed carbon is a characteristic in part specific to the particular asphalt question and in part dependent upon method of manufacture. To be more explicit, straight Mexican asphalt of a certain consistency will show a higher percentage of fixed carbon than an asphalt from Mid-Continent crude of the same consistency, but if the Mid-Continent asphalt were not properly refined, it might show as much fixed carbon as the Mexican product. It will thus be understood that the fixed carbon does not give a definite idea of quality unless knowledge is at hand as to the source of the material. It is, therefore, a dangerous requirement to place in a specification.

The same remark holds good in connection with

Solubility in Light Naptha—The percentage soluble is dependent upon degree of decomposition and also the particular individuality of the crude base.

Paraffine Scale—This test has been very much abused by employing it to excite prejudice against certain classes of material. Paraffine scale accompanies asphalts made from Light Mexican, Kansas-Oklahoma and Illinois crudes, but is negligible in similar products derived from Heavy Mexican, California and certain Texas crudes, as well as in most asphalt cements prepared from native asphalt. It has never been clearly shown that paraffine scale is at all injurious. Much adverse sentiment was directed against materials containing paraffine scale, which apparently was all based on the action of certain native asphalts when fluxed with various classes of flux oils. A flux oil showing a moderate amount of paraffine scale was found to be unsuitable for fluxing with Grahamite, while a flux of similar consistency obtained from a crude oil showing low paraffine scale would make a smooth, satisfactory material when so fluxed. Naturally this made the paraffine scale an important test in specifications for a flux suitable for fluxing with Grahamite, but it will be readily seen that if an asphaltic material, either straight petroleum or fluxed native asphalt, is perfectly smooth and homogeneous and has all the other desirable qualities, the mere fact of its containing paraffine scale is of no importance.

When the asphalt road work began to make such rapid progress some ten or twelve years ago, a great many chemists and engineers were called on to specify asphaltic material, and it is not surprising that thru ignorance and improper qualification, more importance was attached to paraffine scale than it warranted. The test in itself would not be so objectionable to the manufacturer, if it were a thoroly standardized test and capable of yielding concordant results. Unfortunately this was not the case. Few operators agree within large limits upon how much paraffine a specimen of asphalt contained. Fortunately, as years go by, this is becoming clearer to those interested and the paraffine test is gradually becoming obsolete.

The term *Asphalt Content*, probably originated in the days when the heavy California petroleums first came to notice. Crude oil was said to contain a certain percentage of asphalt. The character of the asphalt implied was of standard grade, perhaps 50 or perhaps 100 penetration. The method of getting at this consisted in heating a sample of the crude or other asphaltic material to a temperature below that at which decomposition would take place until the material, thru evaporation, had the penetration of the commercial asphalt. This worked out fairly well with asphalt of the California type, but when the Kansas-Oklahoma and Illinois asphalt began to appear, it was not such an easy matter to interpret the results of the test. The difficulty was that in the case of California grade the asphalt existed in solution in a comparatively volatile petroleum oil, while in the case of the Mid-Continent grade the asphalt which it was sought to determine was held in solution in a non-volatile oil. The consequence of these facts was that, when the two were heated, the volatile oils were driven off from the California grade while the Mid-Continent product was oxidized or hardened artificially without driving off any of the non-asphaltic bodies. This brought about the anomaly of a liquid asphalt product showing, by test, almost 100% of a solid product. To overcome this, operators employed various means of driving off the oils without oxidation or decomposition, but none of these means has resulted in a thoroly satisfactory test which can be applied universally to asphaltic products from all sources. As the matter thus stands, great caution must be used in dealing with the test for asphalt content.

The test for asphaltic content applies to crude material, fluxes and binders, but not, of course, to paving asphalt of standard consistency, as this it is sought to determine. This item more properly belongs with the subject of road oils, and the above remarks should be remembered later when they are discussed.

Process of Manufacturing Road Oils

So far consideration has been given only to solid or nearly solid asphalts for the construction of permanent roadways. There is another class of asphaltic materials used for the purpose of laying dust and making surface repairs to worn roadways, of either water-bound or other types. These may be classed as follows:

1st. Dust Preventives—These consist of oils containing some asphalt, but sufficiently liquid to be applied cold and penetrate to some depth into the dust in order to prevent it being carried by air currents.

2d. Cold Application Oils—These are for similar purposes to the first mentioned class, but are somewhat heavier and altho they may be applied cold, it is necessary to atomize them to secure the proper distribution. They are light enough so that no cover need be applied.

3d. Hot Application Oils—This class is heavier than either of the foregoing; must be applied at a temperature of approximately 250° F., and covered after application with coarse sand or screenings. The object is to form a hard crust or carpet on the surface of the roadway.

The *Light Asphaltic Oils* act in a very similar manner, but they have a little greater body and will permit of more compacting of the dust than the non-asphaltic grade. Light asphaltic oil is usually made by steam reduction of the basic crude oil to remove all of the more volatile products such as gasoline and kerosene. If the body of the oil is then too heavy, it is thinned with comparatively non-volatile distillates, such as those which are ordinarily furnished to the gas companies for the manufacture of carburetted water gas.

Cold Application Oil is made in precisely the same way, but the steam reduction is usually carried a little farther to obtain the heavier body required for this purpose.

Hot Application Oil. When this material is desired, the concentration is carried still farther, being stopped when the residuum assumes a consistency suitable for use from a pressure distributer at about 250° F. The manufacture is carried on in the same type of still, being the standard still for asphalt manufacture.

It will be noted that in the first part of this paper the consistencies were determined by means of the penetration instrument. In the grades now being considered, however, only the hot application oil lends itself to testing by this instrument.

As the products become more liquid, the penetration instrument is not suitable for determining their consistency, for they pass out of the range of this instrument. It is, therefore, necessary to resort to some other measuring device. It is usual practice to state consistency of road oils in terms of viscosity at fixed standard temperatures near those at which the materials are intended to be applied.

Viscosity is indicated by the rapidity with which material will pass thru a certain orifice under a given head, and at a definite standard temperature. It will thus be seen that it is very closely connected with the speed at which it runs thru either a pressure or gravity distributer. When the viscosity of an oil is once determined, which satisfactorily passes thru the distributer, its duplicate in this respect can be manufactured without any difficulty. It has been found good practice to make non-asphaltic oils of such viscosity as to pass the Saybolt Universal viscosimeter in from 50 to 100 seconds at 100° F.

Light asphaltic oils, for the same purpose, will pas thru the same instrument at a temperature of 130° F., in from 300 to 400 seconds, while the Cold Application Binder will require from 400 to 500 seconds at the same temperature.

Hot application binder, as already stated, is too heavy for rapid and reliable testing on this instrument. It is usually manufactured to show a penetration at 77° F., under the usual conditions, of approximately 200.

It has probably been noticed that as the consistency of the material increases, the more permanent is the roadway into which the product has entered, and it has probably already been surmised that the reason for this is the increase in the percentage of asphalt in the product.

At first thought it would seem, inasmuch as the asphalt appears only to thicken the oil, and further that the oil is practically non-volatile, the binding quality of the oil in the mineral matter of the road could not exceed its original strength. But this does not seem to be the case, and various theories have been advanced to explain the cause. It is known that a thick oil will take on an entirely different consistency by mixing in with it a very fine dusty substance. This may be due to a physical compacting of the dusty material aided by the oil, but there is some reason for believing that it might be due to asphaltic bodies being retained by the mineral matter thru absorption and permitting the oil to seep away into the drier portion of the aggregate by capillarity.

Thus it is desired, if working toward permanency of roadway, to employ an asphaltic material as rich in asphalt as possible. Unfortunately there is a limit which prevents going too far in this direction. As asphalt increases in the oil, the oil becomes thicker, and it fails to penetrate into the mineral material. It will, therefore, be noted that the process of application must be governed by the amount of asphalt existing in the road oil which it is desired to use. This again brings up the importance of a test for asphalt content, already referred to under asphalts, but thru the difficulties of handling such a test, and due to the fact that investigation has shown that asphaltic content, determined by actual steam reduction, closely follows viscosity, the latter has found quite universal application as an index of the amount of asphalt in solution.

With these facts in view, the manufacturer, in making road oils, is governed principally by viscosity and by the flash test, also of great importance as indicating the safety in handling.

Before taking up the tests in general, mention should be made of the so-called *Cut-Back Road Oils*. These are usually prepared by the steam reduction of the crude oil to a point where consistency is reached, which is believed to be the ultimate one desired in the finished roadway, and which is usually, if not always, much too heavy to apply by the method available.

It is, therefore, necessary to thin this ideal binding material to a point which will permit its application and to this end it is softened with some light petroleum product, which will evaporate after the road has been in service. This usually means a product which naturally goes into gasoline, and, therefore, brings a high price, which from an economic standpoint, is undesirable. That is to say, a greater amount of good may be done for the public at large by furnishing this volatile solvent for motive power purposes rather than for road oil.

Another product which found a great deal of favor some years ago, but appears now to be in less demand, is an *Emulsified Oil*. This is made by treating asphaltic material of suitable consistency with various emulsifying agents, which sub-divide it into very small particles and permit them to be held in suspension in water. An emulsion so prepared will be quite liquid, so that it may be applied thru an ordinary water sprinkler and thus the asphalt made to reach all particles of the mineral road material.

They make excellent dust-layers of heavier body than straight oils, but have, in the last few years, been largely replaced by straight asphaltic oils, probably thru the discovery of improved methods of application.

Tests

As already remarked, the manufacturer of road oils is guided almost exclusively by viscosity, using it as a measure of consistency and percentage of asphalt, but outside of this, other tests, which find their way into specifications, should receive some attention.

Specific Gravity means very little when taken by itself, but will give considerable information as to the origin of the asphalt contained in the road oil if first the volatile oils are removed to bring the asphalt to a standard consistency before determining its specific gravity. After all this has been done and the geographical source of the base located, information indicative of quality is still lacking.

Flash Point—The value of flash point resides in its indication of the safety of the oil at the temperature to which it may be desired to heat it. With regard to the light road oils and cold application oil, which never become heated above summer temperatures, a flash point above 150 or 200° F. is unnecessary. In the case of an oil which is used for hot application or an asphalt which must be melted before fluxing, a high enough flash point must be maintained to prevent it from firing in the kettle or container in which it is heated. Usually a point between 350 and 400° F. suffices. In the case of a cut-back oil, it is more or less common to indirectly specify the volatile solvent by calling for a low maximum flash point, around 100° F. This is of course at the sacrifice of safety to some extent.

Viscosity: As already stated, viscosity, in connection with road oil, is one of the most important requirements. It should be ascertained at a temperature as near as possible to the temperature at which the oil is to be applied, but inasmuch as instruments for determining viscosity are standardized and used at a few definite temperatures, it is customary to take the viscosity of the road oil at a standard temperature nearest to the application temperature; thus a medium asphaltic oil may be determined in the Saybolt Universal instrument at 130° F. or in the Engler instrument at 122° F. (50° C.).

With light hot-application oils the temperature best adopted is 212° F.

Loss at 325° F. and consistency of Residue—This test is to furnish information as to the degree of thickening which takes place in an asphaltic material after it goes into service, as the amount which evaporates on the road is, in a measure, indicated by what evaporates at 325° F. in the laboratory. The test has particular value in connection with cut-backs where a specific consistency, after weathering, is required.

Solubility in Carbon Disulphide—As already stated, under asphalts, this is a test for purity and has no other value.

Solubility in Light Naptha—This test, together with specific gravity and others, when applied intelligently, furnishes statistical information as to the geographical origin of the asphalt. So far it has not been demonstrated that figures obtained by this test have any other value.

It often happens that an attempt is made to draw specifications without knowledge of the manufacturing possibilities, so that it is not uncommon to meet with a specification which, in addition to the essential characteristic, namely consistency, includes various other tests of narrow range, limiting the various characteristics which have been discussed above, in such a manner that the specification becomes a manufacturing impossibility.

It has already been shown that with a fixed base, such as Light Mexican crude, for example, the manufacturer is substantially limited to one process in making all road oils and road asphalts, and that the final degree of fluidity or hardness, whether liquid or solid, depends upon the extent to which distillation is carried. If then, curves are plotted, taking melting point, gravity, flash volatility, fixed carbon, asphalt contents, consistency at abnormal temperatures, etc., against consistency, it will be found that all of these curves are regular and that for a given range in consistency there will be definite corresponding ranges in the other tests enumerated.

It is, therefore, apparent that if specifications are not consistently drawn, it will be impossible for the manufacturers to meet them with certain crude base stocks, by employing the most approved manufacturing methods.

This shows the importance of the users keeping in touch with the manufacturers in order to learn what is possible. Manufacturers is used in the plural advisedly, for one may advise limits for some of the unimportant tests to fit his particular base stock, and at the same time shut out another who makes an equally good product with a different base stock.

The Asphalt Association has for some time been working in the direction of getting the manufacturers together and there is reason to hope that they will in time also secure the cooperation of the state and city officials. When this becomes a fact, much of the present difficulty in connection with the specifications will disappear.

It should also be stated that those connected with the U. S. Bureau of Public Roads have taken it upon themselves to become acquainted with manufacturing possibilities, and have drawn excellent specifications for road oils, binders, etc. endeavoring to make them consistent with such limitations.

PLANT INSPECTION OF PAVING MATERIAL

By George Cobb, Asphalt Material Engineer, Baltimore, Md.

The man who first said that "An ounce of prevention is worth a pound of cure" undoubtedly had served an apprenticeship as an asphalt plant inspector. It is at the plant and not on the street that the "hot stuff" can either be made or broken.

Preliminary Inspection

Bearing in mind this "ounce of prevention" adage, we must begin our preliminary work before the paving material reaches the plant. First and most important, the source of the material itself must be known to the engineer in charge of the paving mixtures. Fortunate indeed is that engineer if his asphalt is to be purchased from a local refinery. Such being the case, he can have stills of A. C. run down to whatever penetration he desires under the joint control of the refinery chemist and one of his own men. Or if a "natural" asphalt is specified, the fluxing up to the required penetration is obtainable under the same inspection. To those who may have been forced to close down a paving plant, in the past, for some hours, in order to flux up or lower the penetration of a refractory kettle, such a method of predetermining the penetration is little short of a godsend.

And so with a sand bank, or neighboring river bottom. Show me the bank that does not boast its own peculiar strata of dirt and clay! A watchful inspector at this point would cull out the dirt before it was loaded. Let this same inspector acquaint himself with the sand bars where the river sand is dredged. A word from him at the right time will prevent the captain of the dredge from sending up a whole scow load of improperly graded sand. Thus down the entire list of paving materials—the binder stone, the gravel, the filler. Become familiar with each brand of material itself but primarily, gain a full knowledge of the source of supply. By so doing, much valuable time can be saved and many heated arguments avoided.

Three Systems of Plant Inspection

There seem to be three common systems of plant inspection in use to-day. First: Where a municipality hires a private laboratory in some distant city to send on an inspector. This man may be experienced and capable but at best it is a crude method, as he will be compelled to forward samples of his materials and mixtures to his home laboratory and await their decision before making any changes in his batch formula. In the meantime, many yards of improperly proportioned pavement will probably have been laid. The second method and doubtless an improvement on the first, is to employ a company that will send a chemist with a field laboratory to the scene of action. It is obvious that under such an arrangement, needed corrections in the mixtures can be speedily effected. The third and to my mind, the best method, is for the city or state to establish its own laboratory and organization. By so doing, the chemist in charge makes himself acquainted with all sources of material, places an inspector at each plant that is to operate and systematically keep in daily touch with plants, the "hot stuff" in transit and while it is being laid on the street. He samples the mixtures at the plant and from the street as well. With a capable laboratory force it is possible to get finished results of the composition of the mixture within three hours after taking the sample. At the plant, the inspector keeps a record of the total batches of material mixed and sent to the street. On the street, a second inspector keeps a daily yardage record. By determining the number of square yards of material that should be derived from each batch, at a given thickness after compression, it is possible for the chemist to make a daily check as to whether the finished mixture is being raked to too thin a depth. It is not intended to advocate the third method for small towns. Needless to say, the cost of inspection in such a case would be prohibitive.

At the Plant

At the plant itself the inspector has a wonderful opportunity to employ, among other things, good hard common sense. All materials, immediately upon their arrival, are sampled by him and the laboratory notified. He is instructed after they have been examined, as to the batch formula to employ. Now if the plant inspector will make it a point to especially see to it that the correct proportions of sand are fed and will balance his asphalt bucket after every two or three loads, surface mixtures will not fail to leave his plant with striking uniformity.

The failure of the mixer man to properly drain his asphalt bucket, or the other extreme, to run it over, is probably responsible for more irregularity in bitumen content than any other one reason. When "binder" is being turned out, it appears to be good practice to allow some little leeway to the mixer man. Say we are using a 15 ft. box and adding 15% of sand to the binder stone and have set the A. C. scales at 80 lbs. For some six or seven batches this amount of A. C. may be exactly right. However segregation is bound to occur in the aggregate storage bin with the result that the next batch may be deficient in fine material, the following one having an excess. It is apparent that in the one case 80 lb. is too much and in the other, not enough. Under the watchful eye of the plant inspector, allow the mixer man to use his own judgment to an extent. This may appear to be bad practice—the writer has seen more uniform binder laid, when mixed in this fashion than where the buckets were actually balanced for each batch, as in the case of the surface mixture.

The inspector would do well to go slowly about changing the proportions of sand he is feeding. It is very easy to secure an unrepresentative sample from the hot sand bin. Let him verify his first screening before making a change. Otherwise he may hopelessly unbalance his mixture by snap decision changes. Another important point to bear in mind—even a good cook may burn her bread—the oldest drum fireman in the game may lose control of his temperatures. When this happens the inspector should have the aggregate bin emptied entirely before any material is mixed. The blended sands may thus be used again. Once the A. C. is added, the mixture must be condemned and represents a total loss.

Conclusion

There are many practical "pointers" about the operation of an asphalt plant that can be gained by experience but let me emphasize the fact, that once the fitness of the materials is determined, before allowing them to reach the plant, then the battle is half won.

THE PROPERTIES OF MINERAL AGGREGATES AVAILABLE IN THE METROPOLITAN DISTRICT

A Study of the Proportioning of Concrete

By E. E. Butterfield and C. C. Robesch, Boro of Queens, Long Island City, N. Y.

In the course of the routine work of the laboratory of the President of the Boro of Queens, a number of aggregates have been examined as to grading and other properties in conjunction with the strength of the concrete in which the aggregates were used. The variety of aggregates submitted in connection with sewer and highway construction was fairly representative of all materials available in quantity, but in a few instances where known aggregates were not submitted in the course of contract work or where an aggregate had been submitted in some sizes but not in others, the gaps in the series were filled in by materials furnished by the stone or gravel companies or their dealers. While this series of tests was under way, important contributions to the theory of proportioning concrete have appeared, particularly the works of Professor Duff A. Abrams and Professor Arthur N. Talbot. Comprehensive tests on the properties of coarse aggregates have also appeared in Technologic Paper No. 184 of the United States Bureau of Stanards, in connection with fire tests of building columns. These investigations are mentioned because they all lead to the same conclusion, namely, that the strength of concrete is widely independent of the nature of the coarse aggregate.

At different times in the past various statements have been made as to the superiority of one kind or another of broken stone or gravel for concreting, and test data have been incorporated in tables in engineering text books and manuals. However, the broader conclusions of Professor Abrams and of Professor Talbot reached independently by different methods, one from a study of the fineness modulus of the aggregates and the water-cement ratio of the concrete, and the other from a study of the voids in the mortar, both indicate a general independence of the strength of the concrete from the mineralogical nature of the coarse aggregate, which is confirmed in general by the studies of the United States Bureau of Standards. This generalization, of course, does not apply to artificial aggregates, such as cinders or to aggregates of freak sizing or grading. It would seem, therefore, that there is ample evidence at hand to indicate that there is little or no justification for the preferential specification of one kind or another of coarse mineral aggregate as far as any relation between its mineralogical nature and the strength of the resulting concrete is concerned.

There is also ample evidence in the field to raise grave doubt as to any decided superiority of one kind of coarse aggregate over another for any of the purposes for which cement concrete is used, with one exception in the special case of resistance to fire, i.e. the protection afforded at high temperatures by concrete to metallic reinforcement, where there seems to be a definite order of resistance to fire by different coarse aggregates more or less in accordance with the mineralogical nature of the aggregates. According to the report of the United States Bureau of Standards made in collaboration with the Underwriters Laboratories, there are marked differences in the fire protection afforded by broken limestone or calcareous gravel aggregates, both of which offer the greatest protection, as compared with siliceous or quartz gravel aggregates which offer the least protection, with trap rock, sand stone, granite and cinder aggregates intermediate between the calcareous and siliceous aggregates in their fire resisting properties (Technologic Paper 184, p. 205-209, United States Bureau of Standards).

Our results confirm in general the foregoing statements. It must be borne in mind, however, that in practical work it is exceedingly rare to encounter different coarse aggregates of identical grading and water absorption, and still more rare to have the field concrete made up with exactly the same consistency and water ratio; all of these factors affect appreciably the strength of the resulting concrete and explain, in our opinion, why nominal 1:2:4 mixes of different coarse aggregates or different sizes of the same aggregate do not always give identical compressive strengths.

However, when consistency and mix are carefully controlled, a practical identity of strength is found, as in the case of two of our jobs where a strength requirement was made the main feature of the control work, altho the aggregate in one case was ¾-inch trap rock and in the other case was the run of crusher limestone from 2¼-inch down. These mixes were used in special construction where resistance to salt water action or imperviousness to water were primary considerations. Samples were taken both from the concrete mixer on the job and from the materials on the job mixed in the laboratory in the same proportions as used in the work. The mixes varied from, 1:1.7 : 2.3 to 1:1:3. The averages for water ratio, consistency, and compressive strength are practically identical.

Location of Work	Contractor	Aggregate	Mix	Water Ratio	Slump of 16" cylinder	Compressive Strength 28 days
43rd Street Sewer outlet	Hazell & Company	¾" Trap Rock	1:1.6:2.4	0.61	8½	3224
Pumping Station Genesee Street and North Conduit Avenue	Fox Reynolds Company	Limestone run of Crusher	1:1.3:2.8	0.62	7¾	3369

Analyses of Rock Powders

Nature of Material	Source	Insoluble in Acid	Al_2O_3 and R_2O_3	CaO	MgO	CO^2
Trap Rock..................	Rockland Lake, N. Y.	86.5	9.4	2.8	0.9	0.2
Limestone (Dolomitic)......	New Hamburg	9.6	1.6	30.0	17.8	40.7
Limestone (Dolomitic)......	Tomkins Cove	9.8	0.6	30.2	17.3	42.1
Gravel (Quartz)............	Port Washington	93.6	5.5	0.5	0.3	—
Gravel (Blue)..............	Marlboro	78.3	7.6	6.1	1.7	4.7

DISCUSSION

HARRY J. CLEWS (by letter): I should like to ask Dr. Butterfield if there are chemical or other criteria which would justify sharp distinction between the Chicago limestone and Hudson River limestone, and further if there are essential differences in the Hudson River limestone, particularly from the quarries at Tomkins Cove, Cedar Cliff and New Hamburg.

We have long been of the opinion that the Hudson River limestones were of practically the same nature and this opinion has its foundation in their identification by the United States Bureau of Public Roads. Dr. Butterfield's analyses appear to furnish further confirmation of the Government data.

The subject is of interest because of the commercial exploitation of the two Hudson River quarries as sources of only true dolomite whereas a much purer dolomite is sold in Chicago as limestone.

In this connection we, and I speak as secretary and treasurer of the Tomkins Cove Stone Company, have recently received the following communication from the chief chemist of the New Jersey State Highway Commission:

"Calvin Tomkins Co.,
No. 30 Church Street,
New York City.

Gentlemen:

On Sept. 7th this office received two small boxes of stone marked as follows:

Trap Rock Group

Source of Material	Size		Sand	Fineness Modulus Whole Aggregate	Mix	Water Cement Ratio	Size of Test Cylinders Inches	Consistency; Slump of fresh concrete cylinders Inches	Weight of 28 day concrete Lb. per Cu. Ft.	Compressive Strength at 28 days Lb. per Sq. In.
	Sieve or Screen Openings Inches	Commercial Designation								
Rockland Lake, N. Y.	¼ to 2¼	Run of Crusher	Cow Bay	6.2	1:2:4	0.9	6×12	—	157.6	1430
Rockland Lake, N. Y.	¼ to 1½	¾″	Cow Bay	5.4	1:2:4	1.0	6×12	4½	151.4	1048
Rockland Lake, N. Y.	¼ to 1½	¾″	Cow Bay	5.4	1:2:4	0.9	6×12	1¾	152.1	1439
Rockland Lake, N. Y.	¼ to 1½	¾″	Cow Bay	5.4	1:2:4	0.8	6×12	0	150.0	1630
Rockland Lake, N. Y.	¼ to 1½	¾″	Cow Bay	5.4	1:2:4	0.6	6×12	0	143.9	1326
Rockland Lake, N. Y.	0 to ⅜	Screenings	None	3.8	1:5	0.9	6×12	—	155.7	1220
Rockland Lake, N. Y.	¼ to 2¼	¾″	Cow Bay & Fine Sand Equal Parts	5.3	1:1.7:2.3	0.68	8×12	9	152.8	3517
Rockland Lake, N. Y.	¼ to 1½	¾″	Cow Bay	5.5	1:1½:2½	0.54	8×16	8	152.5	2931

Limestone Group

Source of Material	Size		Sand	Fineness Modulus Whole Aggregate	Weight of Dry Aggregate Lb. per Cu. Ft.	Mix	Water Cement Ratio	Size of Test Cylinders Inches	Consistency Slump of Fresh Concrete Cylinders Inches	Weight of 28-day Concrete Lb. per Cu. Ft.	Compressive Strength at 28 days Lb. per Sq. In.
	Sieve or Screen Openings Inches	Commercial Designation									
New Hamburgh	¼ to 2¼	Run of Crusher	Cow Bay	6.2	—	1:2:4	0.9	6×12	—	150.6	1469
Cedar Cliff	¼ to 1⅝	Run of Crusher	Cow Bay	6.1	— —	1:2:4	0.9	6×12	—	154.6	1385
Tomkins Cove	¼ to 2¼	¾″	Cow Bay	5.3	—	1:2:4	0.8	6×12	—	151.3	1722
Tomkins Cove	¼ to 2¼	¾″	Cow Bay	5.3	—	1:2:4	—	8×16	15	152.9	1749
Tomkins Cove	¼ to 2¼	¾″	Cow Bay	5.3	—	1:2:4	0.8	8×16	5	153.4	2362
Cedar Cliff	0 to ⅜	Screenings	None	3.7	—	1.5	0.9	6×12	—	143.4	1050
Tomkins Cove	¼ to 2¼	Run of Crusher	Cow Bay	5.7	126.5	1:1½:2½	0.65	8×16	7¼	154.2	3280
Tomkins Cove	¼ to 2¼	Run of Crusher	Cow Bay	6.4	12[illegible].5	1:1:3	0.59	8×16	8¼	157.2	3459

Hudson River Gravel Group

Source of Material	Size		Sand	Fineness Modulus of Whole Aggregate	Weight of Dry Aggregate Lb. per Cu. Ft.	Mix	Water Cement Ratio	Size of Test Cylinders Inches	Consistency Slump of Fresh Concrete Cylinder Inches	Weight of 28-day Concrete Lb. per Cu. Ft.	Compressive Strength at 28 days Lb. per Sq. In.
	Sieve or Screen Openings Inches	Commercial Designation									
Marlboro, N. Y.......	¼ to 1½	¾″	Cow Bay	5.8	125.9	1:2:4	1.0	6×12	6	146.0	1549
Marlboro, N. Y.......	¼ to 1½	¾″	Cow Bay	5.8	125.9	1:2:4	0.9	6×12	½	145.6	2197
Marlboro, N. Y.......	¼ to 1½	¾″	Cow Bay	5.8	125.9	1:2:4	0.8	6×12	0	149.7	2139
Marlboro, N.Y.......	¼ to 1½	¾″	Cow Bay	5.8	125.9	1:3:6	1.0	6×12	0	143.2	1608
Marlboro, N. Y......	¼ to 1½	¾″	Cow Bay	5.8	125.9	1:3:6	0.8	6×12	0	144.7	1551

Silicious (Quartz) Gravel

Source of Material	Size		Sand	Fineness Modulus of Whole Aggregate	Weight of Dry Aggregate Lb. per Cu. Ft.	Mix	Water Cement Ratio	Size of Test Cylinders Inches	Consistency Slump of Fresh Concrete Cylinder Inches	Weight of 28-day Concrete Lb. per Cu. Ft.	Compressive Strength at 28 days Lb. per Sq. In.
	Sieve or Screen Openings Inches	Commercial Designation									
Loyds Neck, L. I..........	0 to 1½	¾″ mixture	Of Mixture	5.5	122.0	1:2:4	1.0	6×12	10	145.0	2027
Loyds Neck, L. I..........	0 to 1½	¾″ mixture	Of Mixture	5.5	122.0	1:2:4	0.9	6×12	1	147.7	2750
Loyds Neck, L. I..........	0 to 1½	¾″ mixture	Of Mixture	5.5	122.0	1:2:4	0.8	6×12	0	145.9	2087
Port Washington L. I...............	0 to 2½	1½″ mixture	Of Mixture	5.9	130.5	1:2:4	0.84	6×12	6	148.0	2137
Port Washington, L. I...............	0 to 2½	1½″ mixture	Of Mixture	5.9	130.5	1:2:4	0.74	6×12	1	149.1	2310
Loyds Neck, L. I.........	0 to 1½	¾″ mixture	Of Mixture	5.5	122.0	1:3:6	1.0	6×12	0	137.4	990
Loyds Neck, L. I.........	0 to 1½	¾″ mixture	Of Mixture	5.5	122.0	1:3:6	0.9	6×12	0	135.6	991
Loyds Neck, L. I.........	0 to 1½	¾″ mixture	Of Mixture	5.5	122.0	1:3:6	0.8	6×12	0	136.0	913
Port Washington................	0 to 2½	1½″ mixture	Of Mixture	5.9	130.05	1:3:6	0.91	6×12	6	146.9	1538
Port Washington................	0 to 2½	1½″ mixture	Of Mixture	5.9	130.05	1:3:6	0.78	6×12	1	147.4	1738

"Sample of Tomkin's Cove dolomite, submitted by the Calvin Tomkins Company for use on Section 10 of Route 1. Contractor C. H. Winans Co."

This material complies with our grading requirements for concrete stone and is approved for use where limestone, concrete size is specified.

Material represented by these samples, however, is rejected for use on Route 1, Section 10, since the specifications for this work call for trap rock or dolomite.

Very Truly yours,
(Signed) R. B. GAGE,
Chemical Engineer,
GF Bragg, VB. Quarry & Taylor Place."

The position of this chemist for the N. J. State Highway commission appears to us in view of the facts, to be wholly untenable. There is practically no such thing as pure dolomite in the market. All of the commercial stone products in this Metropolitan district are silicious dolomites of practically the same composition whether sold as limestone or dolomite."

GRANITE BLOCK REPAVING IN BALTIMORE

By Nathan L. Smith, Associate Civil Engineer, Highways, Baltimore, Md.

For a great many years, Baltimore enjoyed the unenviable reputation of being called the "Cobble Stone City." Visitors coming here after being bounced over several squares of this type of paving went away with a more or less unhappy recollection of our city. In addition to the cobble streets, we had several square yards of another type of pavement, which was almost as unpopular with teamsters and motorists, namely stone block on a non-rigid base with a sand filler. The replacing of these relics of bygone days with more modern types of paving, in addition to the improvement of suburban streets which have never been paved, is one of the tasks confronting the paving organizations of this city.

Our operations in the down-town sections during the present year have been confined mainly to the laying of two types of paving, namely sheet asphalt and granite block.

We have laid several hundred square yards of vitrified bricks, especially in gutters where there is a daily flow of water, and have done about fifteen squares of cement concrete paving, but by far the greater area has been covered with one or another of the aforementioned types of surfacing. To be specific, about 72% of the paving laid or contracted for in the old city in 1921 has been sheet asphalt, 21% granite block, and the remaining 7% all other types, in a total area of approximately 260,000 square yards. We are now asking for bids on 2,600 square yards of new granite block paving to be laid on an existing concrete base in the railway area on the third section of the Key Highway. This paving will include a mortar bed (one part cement to three parts sand) and a cement filler (one part cement to one part sand).

However, the phase of our work which I wish to bring to your attention deals with the utilization of granite blocks which have been in service on our streets for several years until the filler has disappeared, the blocks have become rounded and worn, and the sub-base has failed in places, causing an irregular cross-section. We have torn up approximately 80,000 square yards of these streets during the present year and either repaved them with sheet asphalt or recut the blocks and relaid them on a concrete base. We arrange our work so that there shall be enough old block streets torn up to supply our needs for these blocks for relaying.

To those of you who are familiar with Baltimore, I might mention some of the streets covered in this manner. Early in the year we awarded contracts for repaving the following old granite block streets with sheet asphalt:—Maryland Avenue from North Avenue to Twenty Fifth Street, and North Avenue from Charles Street to McMechen Street. At the same time we awarded the repaving of these old granite-block streets with recut granite blocks: Charles Street from Barre Street to Lombard Street, Lombard Street from Hanover Street to Charles Street, and Redwood Street from Eutaw Street to Howard Street. A contract had also been given for the paving of Lombard Street from Fremont Avenue to Payson Street, an old cobble stone street 14 blocks in length, with sheet asphalt, granite blocks to be laid as liners along each side of each rail of the street car tracks and in the intersections which were subjected to the heaviest cross traffic, while still another contract was awarded for the paving of Center Street from the Fallsway to St. Paul Street, an old cobble street, with recut granite blocks.

Sufficient blocks for the liners along the rails on North Avenue and Maryland Avenue and in the main intersections were piled in a convenient place for recutting and those similarly needed for liners and intersections on West Lombard Street were sent to that locality to be dressed and used. The remaining blocks were hauled to Center Street for the repaving thereof and to South Charles Street to make up for the loss occasioned by recutting the blocks taken therefrom. This loss has usually run in the neighborhood of 15%.

Let us now consider the methods involved in this work of repaving. While the subgrade is being prepared and the concrete base laid and cured, the contractor has men recutting the old blocks. The average block, when taken from a pavement, is approximately 11 inches long, 4 inches wide, and 5 inches deep. These blocks are rounded on the faces which have been exposed to traffic. The method of dressing these old blocks so as to have the least waste is to split them in half at right angles to their longest dimension. This is accomplished by notching the face with a chisel and striking the opposite face with a hammer. The blocks usually fracture uniformly, producing two blocks approximately 5½″ x 5″ x 4″. The rounded faces are then squared to true rectangular form, free from bumps, so that, when laid close, they shall have joints not exceeding three-quarters (¾) of an inch in width. Blocks which are not long enough for splitting are dressed to form true rectangular faces and laid as before. Of course, when blocks are cut for liners they are not split, but are carefully dressed with as little waste as possible, and laid with the longest dimension parallel to the rail.

Contractors on our work this year have employed from ten to twenty-five block cutters, in proportion to the size of the contract, the time allowed, and the number of pavers employed. These cutters, have averaged over 500 blocks per 8-hour day. They are paid at the rate of $18.00 per thousand blocks. Allowing 45 blocks to the square yard, the cost of cutting the blocks amounts to about 81 cents per square yard. On South Broadway we encountered a much harder grade of stone than on any other street undertaken this year, and this has held the average number of blocks cut per day lower than it would otherwise have been.

The majority of the pavers employed by our contractors and sub-contractors this year have done excellent work, but there have been times when we were unable to get as many men as we wished. It was said that there were but thirty union pavers in Baltimore this summer, from which it is evident that when several contracts were under way at the same time no one contractor could get very many men. We were especially fortunate in having one sub-contractor who was able to get from three to seven of the best of these pavers and hold them during the most of the summer, and this force did at least 75% of all the granite block paving laid by us this year. We were informed that the union rate of pay for pavers was, or rather is, one dollar ($1.00) per hour, but we understand that the best of these men were given a bonus of 25%, making their earnings $10.00 per 8-hour day.

On South Charles Street this sub-contractor has as many as 8 pavers at work part of the time. In addition to this, he, himself paved about half of the time. These pavers, working approximately 700 hours laid about 5200 square yards of paving, which is at the rate of 7½ square yards per man per hour, or 60 square yards per man per 8-hour day. At $10.00 per day the laying of the blocks on this thorofare cost about 17 cents per square yard. The rammers worked a total of about 150 hours to ram these blocks, averaging 35 square yards per hour or 280 square yards per eight 8-hour day. The wages of these rammers were said to be one dollar ($1.00) per hour, and at this rate the ramming of the blocks cost about three cents (3 cents) per square yard. In order to obtain the total cost of the labor necessary to carry on these paving operations we must add the men wheeling the blocks and distributing them for the pavers, the men mixing and placing the mortar bed, sprinkling this cushion and the blocks ahead of the grouting, and mixing, pouring, brooming, and squeegeeing the grout. A great deal of sprinkling is necessary in warm weather, as the blocks and cushion dry very fast. The first pouring of grout is, of course, quite thin, so that it will penetrate the cushion and firmly bind the blocks to this cushion and to each other. Thicker grout is then used to fill the upper portions of the joints and form a mortar coating over the top of the finished pavement. This grout is thoroly broomed into the voids, and finally flushed with a squeegee. For these operations a small cement mixer and engineer and about 9 laborers are necessary. On the aforementioned work on South Charles Street we found that this labor cost about eleven $1100 or 21 cents per square yard. In paving the 52 square yards on Charles Street, 220 barrels of cement were used in the cushion and 420 barrels in the grout, making a total of 640 barrels of cement. The price of this commodity to contractors has been about $2.87 per barrel, with a rebate of 10 cents per bag returned and 10 cents per barrel for cash. At this rate the cement used cost about $1500 or 30 cents per square yard of pavement. Mixed with this cement were 150 tons of sand in the cushion and 100 tons in the grout, totaling 250 tons, and costing not over $1.00 per ton delivered on the job, or about 5 cents per square yard. Totaling these costs we find that the materials used in connection with the recut blocks costs the contractor approximately 35 cents per square yard. Water is furnished by the city, the contractor being required to make a deposit with the Water Department of a small sum for each hydrant used, to cover the cost of inspection and possible repairs necessitated by the paving operations.

Summing up all these items, we have the following costs per square yard:—

Recutting blocks	.81
Paving	.17
Ramming	.03
Preparing cushion and grouting	.21
Materials in cushion and grout	.35
Total	$1.57

The small amount of hauling required to bring the dressed blocks to the place of paving will add very little to this figure. We require the contractor to haul all blocks unfit for cutting to some point selected by us, and pay him for this and any other hauling of over 1000 feet in length at a given rate per mile or fraction thereof. This hauling cannot be estimated accurately in advance and is therefore taken care of as extra work. All chips, debris, etc., remaining at the point where the blocks were cut, the contractor must clean up and remove at his expense, just as he cleans the newly paved street, and he probably adds a few cents to his unit price for paving to cover this cost.

All our bids received this year for recut granite block repaving have included a 6-inch concrete base and the removal of old material. In other words, if a street is originally paved with cobble stones, the cost of removing them is included in the unit price paid for the repaving, while the removal of the earth below the cobbles to the elevation of our sub-grade is paid for by the cubic yard.

The unit prices for these items received this year on strictly repaving jobs have been as follows:—

Contract	Streets	Gr. Block Repav.	Excavation
179	Charles, Lombard & Redwood	$3.25	$3.25
180	Center	2.83	2.99
186	Columbia, Broadway, & Lombard	3.67	1.30

Averaging these prices, we find that we have been paying $3.25 per square yard for repaving and $2.50 per cubic yard for excavation.

We exclude all vehicular traffic from these newly-paved streets until the grout has been finished fourteen days, and the contractor must keep a watchman on them day and night to insure their protection. As the closing of these streets in the business section for this length of time works quite a hardship on the merchants and other business men of the district, we generally pour the blocks in the main street intersections with asphalt instead of grout, in which case the intersection can be opened to cross traffic as soon as the asphalt has cooled to the temperature of the air. Our bid prices received for granite block paving with asphalt filler are usually about 30 cents higher than the corresponding unit price for cement filler. In the intersection of Columbia Avenue and Fremont Avenue, we tried a combination of the two types of filler, filling the joints for about half of their depth with grout, and finishing with asphalt. The latter material sealed any cracks that might develop in the grout due to the traffic, the cost of both material and protection was reduced, and the street was opened to traffic with very little delay. On January 1, 1922, we will have laid approximately 250,000 square yards of granite block pavements with recut blocks, and on account of the number of old granite block streets with sand filler on a non-rigid base which are becoming too rough for satisfactory travel, notably Madison and Greenmount Avenues, we will have plenty of material for a continuance of this work for the next few years.

Up to a short time ago we allowed the contractors to take all refuse blocks which were too small to redress, or which had been irregularly cut, and he crushed them for his own use in concrete base or other work. However, we now utilize all of these blocks which can possibly be used and lay them in secondary streets and alleys without redressing. The streets selected for this type of paving are those whch are subjected to heavy truck traffic or similar damaging agencies. This year's work includes Cambridge Street, alongside a large can factory, and other industrial plants, and New Street and Academy Alley, in the rear of three of our principal theatres, while a section of the same type of paving was laid in the rear of a large storage warehouse last year. This square, by the way, is standing up excellently under the traffic to which it is subjected. The method of laying these blocks is the same as if the blocks were redressed. Due to the irregularity of the blocks and the difficulty of getting those of uniform thickness in the different courses, as well as to the additional work of shaping the cushion to bed them uniformly, the paving of these uncut blocks is a slower process than that described before. They also require considerably more cement and sand for both filler and cushion than the recut blocks, and these two items increase the cost of the skilled and unskilled labor incident to the paving.

However, the saving of the cost of recutting renders this type of paving much less than the redressed blocks, if a comparison were possible.

The following range of prices for this pavement on a concrete base is shown by the bids received by us this year:—

Contract	Streets	Gr. Block Repaving	Excavation
193	Academy, New, Mace	\$3.00 (4″ base)	\$2.25
194	Cambr., Gwynn, Van Lill, Wagner, Register	2.75 (6″ base)	\$1.45
197	Wayne and Parry	2.85 (6″ base)	1.35

In contract 193 there were three types of paving called for, namely granite block, vitrified brick and cement concrete, and a study of the unit prices leads us to believe that the bidder cut his price on the brick work at the expense of the other two, so the comparison is somewhat unfair. However, we can see from all the foregoing that the average cost of recut granite block paving on a 6-inch concrete base (making a total depth of pavement of 12½ inches) is \$3.25 per square yard and that the culled blocks repaved without recutting on the same depth base and forming the same depth of pavement cost us about \$2.80 per square yard. Our sheet asphalt prices this year, 6-inch base 1½ inch binder course and 1½-inch topping, have ranged from \$3.20 to \$3.40 per square yard, giving us an average cost of \$3.30 per square yard, showing that this type of pavement has cost us about \$.05 more per square yard than recut granite and \$.50 per square yard more than paving the refuse blocks. These asphalt prices are for the city area, the railway area costing about \$.30 per square yard more.

Our results with both these types of repaving have been so satisfactory that we will plan to utilize our old blocks in this manner as fast as the condition of the streets on which they were laid becomes so bad that they have to be renewed.

THE PRESENT ASPECT OF THE PAVING BRICK INDUSTRY AND THE RELATION OF THE MANUFACTURERS TO MUNICIPAL ENGINEERS

By Raymond L. Winslow, President Eastern Paving Brick Manufacturers' Association, New York City

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The purpose of any assemblage of this sort is purely for the object of progress and if we were to be asked what we consider the most important benefit that could accrue to the members of the American Society for Municipal Improvements as well as to the paving brick manufacturers, I would unhesitatingly say acquaintanceship.

The question of the proper relationship between municipal officials and the paving brick manufacturer is so vital in its importance to both that we should strive willingly, earnestly and frankly to co-operate and understand one another to the fullest. It is a matter of mutual concern. The interests of all are so closely interwoven as to make it impossible for any of us to advance without the aid and assistance of the other. Results which both desire can only be effected by a perfectly honest and cordial understanding of the problems which concern us.

Vitrified brick is one of the oldest known paving materials and should be one of the forms of pavement best known. I frankly say, however, that sufficient progress has not been made in securing the results that could be secured. For the past forty-five or fifty years we have been laying brick pavements in this country and we have only fairly started to learn the proper methods of construction, and the field for advanced methods in manufacturing is also large. We should know how to properly build brick pavements, and once built we should not neglect them as we have done in the past. Please understand that under no circumstances do I wish to trespass upon the field of the engineering profession, for I quite well realize my limitations. However, even we laymen have learned some of the knowledge possessed by engineers and put before us by experience. Therefore, we feel it is not improper for us to say that the fundamental basis of any properly constructed highway or street is: first, proper drainage; second, proper preparation of sub-base or sub-soil; third, proper and sufficient foundation on which the top or finished pavement will rest; and still the most important, the proper care and attention to the laying of the surface. A properly constructed brick pavement, as well as any other type of pavement, depends upon the care and attention given by the engineer or those in charge of the construction to these details, and these details we quite naturally and quite willingly leave to the engineer and the municipal officials. The results obtained from proper construction are obvious and it would not be out of place for me to say that there has never been a properly constructed brick pavement in this country which has worn out. Therefore, we do not know the life of a properly constructed brick pavement.

We, as manufacturers, must confine ourselves to manufacturing and delivery. It is to these two features that I ask your attention. To the average person, the manufacture of vitrified brick for street paving purposes appears incomplex. It seems as tho all we have to do is to dig the clay and shale, grind, mold and burn it. That is true, but how many of you realize, as you look at the finished product, what thought, what care, and what attention that piece of burned clay requires before its life starts as full fledged paving material. You cannot visualize what the manufacturer has accomplished unless you have frequently visited his plant and are familiar with the manufacturing processes by which the materials are produced. I will not tire you with the details. They are many and intricate. We feel, however, that, if we were honored by frequent visits from engineers, we as manufacturers would be benefited immeasurably by their advice and suggestions. We believe that a great many of the present annoyances of the manufacturer would be eliminated.

Some of the vexations which trouble both the municipal official and the manufacturer could readily be eliminated. For instance, you will possibly be astonished to know that at the present time there are manufactured in this country more than sixty different sizes and types of brick for street paving purposes. This is a ridiculous situation and should be done away with. It is refreshing and encouraging to know that Secretary Hoover of the Department of Commerce realizes this also and has invited us to send a committee to meet with him and assist in establishing a committee to be known as the Committee on the Elimination of Excess Variety. Secretary Hoover has offered the suggestion that engineers and the paving brick manufacturers strive to get together and eliminate so many varieties and sizes. There should be a standardization of the sizes of brick for paving purposes and of these sizes there should not be more than three or four at the most. Of the types of brick manufactured, we realize that we must make two types, namely, brick with lugs and plain wire-cut brick without lugs, but the size of these two types should without question be standardized. We, therefore, ask you to please be good enough to assist us in arriving at a standardization of the size of brick.

Another and very vital feature to which we particularly call your attention is the question of testing and inspecting brick. There should not be any question as to our ability in arriving at a standardization of the abrasion test required and eliminate the present difficulties that exist in various cities on the rattler or abrasion requirements.

One of the most annoying and troublesome matters that arises continuously in brick paving construction is the question of inspection after the rattler test requirements have been complied with. I, personally, know every brick manufacturer who ships into the eastern territory and I say to you unhesitatingly, and make it as strong as I possibly can, that to my personal knowledge there is not a single manufacturer today who would willingly permit the shipment of a brick from his plant that he did not feel would meet the requirements of the specifications in every respect. This should be apparent to you, even tho we put it on a strictly financial basis, for today with the high cost of production and the still higher freight rates, any loss suffered by a manufacturer owing to rejection of material after delievery is so great that no one would willingly accept the hazard of rejection. The brick manufacturer is constantly inspecting his product both during manufacture and at the time of loading and we ask that the abrasion test and the visual inspection be made at the factory at the time of shipping and not after the delivery of the material along the line of work, for the reason I have just stated. This can easily be done and once accomplished will eliminate a great deal of trouble and expense to manufacturer, contractor and official.

There is another proposition we would like to lay before you for your thought and that is the question of the time of delivery of the material. On any pavement the surface is the last material required by the contractor and it is usually the last material he orders forward. The result of this is that we get our business all in a lump and it is usually during the months of August, September and October that we are asked to ship to any extent. This places a terrible burden on the manufacturer. It confines his business to a very short season and it prevents him from giving the service he would like to give. Some arrangements should be made whereby bricks could be delivered along the line of the work before or during the progress of construction. This would enable the manufacturer to have the bricks delivered so that the contractor could complete the work on time and it would also relieve the congestion at the manufacturer's plant, which as it now stands, is crowded into about three months' time. Some arrangements should be made by the municipalities awarding the contracts whereby the contractor could be paid a certain percentage on material delivered, sufficient at least to enable him to take care of his freight and handling charges. Vitrified brick will not deteriorate and are not subject to any decrease in value whether they are piled on the yard of the manufacturer or delivered at the line of work. Therefore, no risk would be taken by the municipality in making partial payments in advance of the time the material would be required for use.

These suggestions are easy of accomplishment and the primary basis for arriving at this result is acquaintanceship and friendship. I appreciate that there is a difference between the word "acquaintanceship" and the word "friendship." The word "acquaintanceship" means personal knowledge, less than friendship. The word "friendship" means intimacy united with affection or esteem. We pray for your friendship. We feel that we now have only your acquaintanceship and we ask for more. By having your friendship we would then have a better mutual understanding, a closer knowledge of the relation as it should exist between the municipal official and the brick manufacturer. This would all tend to harmony, to knowledge of our obligations to one another and to team work. In that way we could secure results.

During the World's War we were practically out of business. Nearly all paving work was stopped. The result has been that it is only during this year that we have been able to approach within near normal in manufacturing. The increase in freight rates is a severe handicap to the paving brick manufacturer. We have had our troubles—they are all of the past and we look forward to a strong revival in the entire industry and if we can have your help, which we so much crave, we feel that a long step forward has been taken to the mutual benefit of both.

The paving brick manufacturer asks you to feel that we are ready and willing to co-operate with you in every way. I know that I speak for the individual manufacturer when I say to you that we ask your friendship and your help. We want the benefit of your knowledge. Nothing would please the individual manufacturer more than frequent visits to his factory. We would like to act as your hosts. We do not ask that you should thoroly familiarize yourselves with our manufacturing process but we do believe that the joint interest of the user and the producer could be better served by more familiarity on the part of each with the problems of the other.

THE REAL VALUE OF HIGHWAY LITERATURE

By Charles E. Murphy, The Texas Company, New York City

Sir Isaac Newton once said that he did not know how he may have appeared to the rest of the world, but to himself he seemed to be only a small boy playing on the seashore, now and then finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all undiscovered before him.

Sir Isaac must have felt like the American road builder of a decade or more ago, who, confronted with problem after problem of ever-increasing difficulty, found that after he had solved each of these, he had an innumerable number of tasks yet before him. When he had built roads adequate to withstand horse-drawn traffic, he found himself suddenly faced with the task of meeting the highway demands of the rapidly-growing automobile. After he had about found means to cope with the needs of the pleasure automobile, his sigh of relief was rudely interrupted by the cry of the auto-truck for roads to bear its grinding wheels.

But just as Sir Isaac Newton would have found many scientific truths unearthed in the present century that were still undiscovered in his days of the seventeenth century, so the road builder of a few years ago finds that the science of highway building is now well organized, that it has determined certain facts of construction, and that it is constantly growing to a state nearer perfection thru the interchange of ideas and discoveries on the part of those devoting their energies to such tasks.

Just as the interchange of ideas and discoveries marks the progress of other sciences, such as medicine and surgery, so it plays a vital and all-important part in the advance of the science of road construction, so that the road builder in Iowa may profit by the experiences of the highway engineer of North Carolina in solving similar problems; so that the city engineer of Jacksonville may take advantage of the knowledge gained by the engineers of New York, and so forth. These are examples of the great and actual value which an interchange of ideas and experiences effects in the highway field.

Generally speaking, there are two ways in which you in the road building industry pass on your experiences to one another. First, thru your societies, such as the American Society for Municipal Improvements; second thru your highway literature. The importance and activity of such societies as this in advancing the road building science need not be discussed, for it is familiar to all of us. But the second factor, the potent and actual value of highway literature to every one in the road building profession, whether he be engineer, contractor, inspector, or chemist, seems to be in need of our consideration.

Your highway literature of the present day has reached a high plane, whether it be published by the authors of text books, by the Government, by the trade papers, by the material associations, or by the companies in the industry producing highway material and equipment. The purpose of this literature is to disseminate knowledge thruout the profession, which will be useful, helpful and constructive, and it may be said that it is accomplishing its purpose to a certain extent, but is still a considerable way from effecting the maximum assistance to road builders.

Our present-day highway literature may be divided into these classes: (1) Text books; (2) Government publications; (3) Trade publications; (4) That published by material associations; (5) That issued by producers and manufacturers of road building material and equipment.

Considering the part played by each of these, we find first that the text books form the bed rock of this literature; they form the Gibraltar of all information; they deal in fundamentals, give facts and axioms, and are always invaluable for reference and for verification. But just as the highway text books have their advantages, so they have their limitations, dominant of which is the fact that they cannot always be kept exactly up-to-date and modern. So consequently they demand frequent revision if they are not to become obsolete entirely, and highway text books, therefore, may be said to be supplemented by the other classes of literature.

As for the Government publications on road matters, they are written with great thought and attention, and with a firm desire for accuracy even to the smallest details. As a rule they contain articles of more general nature, such as descriptions of Federal-aid work, accounts on highway administration, and so forth, and for the most part this material is gathered and compiled from reports of inspectors and engineers in the field. Because of the delay resulting from this system these publications are often late in spreading information, and therefore are subject to the same criticism that has been made of the text books.

No one will doubt the effectiveness of the trade and engineering papers in the highway industry. Their contents have reached the high plane that has been attained by papers devoted to the other leading industries, and their columns contain abundant information from a perusal of which engineers and contractors will learn many ways of saving time, labor, and expense both for themselves and for the communities they serve.

Ranking in usefulness with the other literature in the field come the live, virile, up-to-date pamphlets and brochures issued by the associations formed to disseminate knowledge regarding the uses of certain materials. I refer to such organizations as The National Paving Brick Manufacturers Association, The Portland Cement Association, the Granite Block Manufacturers Association, The Asphalt Association, and others. The literature regularly issued by these associations, even tho a few paragraphs are rightfully devoted to expounding the good qualities of the material they are interested in, contain the livest kind of construction information. They tell of methods used to expedite the completion of large and small contracts, recount the manner in which certain highway departments or contractors effected extensive labor-saving, publish directions as to the best manner of using their material, giving exact quantities and measurements. Such information as this is of extreme worth to all concerned in highway work. It is helpful to the State highway engineer as well as to the contractor, to the town street superintendent as well as to the consulting chemist.

We pass from these classes of modern highway literature, to the catalogs, booklets, pamphlets, reprints, and articles published and distributed by companies producing highway building materials and equipment. These, too, like the other classes of literature printed for your use, have attained a high plane. An idea of their importance may be gained from the fact that this class of literature now constitutes one of the main features in the libraries of those universities and colleges of the country which give courses in highway engineering. For example, consider the part these instructive pamphlets, booklets, and articles form in the highway engineering course of the University of Michigan, which is headed by such an experienced and widely-versed highway exponent as Professor Arthur H. Blanchard. The booklet announcing the highway course this year at Michigan University states that "The library is equipped with eleven comprehensive indexes covering the books, reports, specifications, pamphlets, catalogs of materials and machinery," and so forth.

You see from this that teachers of highway engineering consider it necessary for their students to have a knowledge of the latest developments in road building materials and equipment, and that one of the best ways to accomplish this is by keeping in touch with the pamphlets and instructive literature issued by the various companies. This literature is used in class work, too, in such institutions as Cornell, University of Virginia, A. & M. College of Texas, Valparaiso University, Dartmouth and others.

Consider the sources of the information contained in the literature issued by the material and equipment companies, and then you will realize why this literature is authentic, practical, and up-to-date.

We find one important source in the trade and engineering papers, which repeatedly contain articles written by your fellow engineers of recognized standing in the highway field. These articles describe actual operations, give helpful instructions and are of consequent value to all interested in highway building. One of the companies particularly interested in the subject described in one of these articles, notes the merit of the description, has the trade paper prepare reprints of the article, and then issues these reprints in the field in order to call particular attention to the subject described.

The information contained in the pamphlets, booklets and other literature issued by the companies comes from an equally practical source. Salesmen with an acute knowledge of highway building and its requirements are constantly travelling from one part of the country to the other. They have many opportunities to see new methods of construction and operations of unique interest, even more opportunities in this regard than the average engineer or contractor. You all know that there is not a more interesting person to talk to than an intelligent, live-wire salesman who knows his business, and it is from the reports of this type of salesman that the companies get up-to-the-minute information on new methods of road construction, novel operations to effect time and labor saving, and so forth. This information, then, forms the basis of some of the literature issued by the companies.

In addition, the companies maintain engineering departments composed of practical road builders who devote their time to actual problems of road construction. The knowledge of these men naturally finds expression in the articles, booklets, and other literature issued.

Now that you understand the authentic sources of the practical information contained in this type of literature, you perhaps will have more confidence in it. It will not only be helpful to you personally, but also to other members of your organization. The strength of your department, if you are a public engineer, or of your contracting firm, if you are a contractor, is largely dependent on the help which you get from your assistants, and hence it is imperative that you keep them well-informed. If an interesting piece of literature reaches your desk, for instance, what an easy matter it is for you to pass it on to others in your organization, or department, after you have finished with it. Or you may wish to order additional copies of it for your fellow workers, and this is easily done, for the companies are only too glad to issue this literature to anyone interested. A request for extra copies of articles, pamphlets, and booklets always is filled promptly.

REPORT OF COMMITTEE ON STANDARD TESTS FOR BITUMINOUS MATERIALS

Your Committee on Standard Tests for Bituminous Materials herewith respectfully submits its 1921 report. This consists of certain changes and additions to the 1920 report. As a matter of general policy this Committee has in the past recommended for adoption tests which have been standardized by the A. S. T. M. wherever such existed or were suitable for the purposes of this Society. Where no A. S. T. M. standard methods existed, methods adopted by other societies or contained in official publications have been recommended with the general understanding that whenever the A.S.T.M. adopted standardized methods which were suitable these were to be substituted for those heretofore taken from other sources. In certain cases the A. S. T. M. have modified some of their previous tests, which entailed a change in the serial designation, and the present report makes such changes in this connection as are necessary.

CHANGES

Penetration Test.—A. S. T. M. Standard Method D–5–21.

Float Test.—A. S. T. M. Standard Method D–38–18.

Ductility Test.—A. S. T. M. Tentative Standard Test D–113–21T.

Solubility of Bitumen in Carbon Tetrachloride.—U. S. Dept. of Agriculture, Bulletin No. 314, page 30.

NEW TESTS

Open Flash.—A. S. T. M. Tentative Standard Method D–92–21T.

Bitumen Soluble in Carbon Disulphide.—U. S. Dept. of Agriculture Bulletin No. 314, page 25.

Organic Matter Insoluble in Benzole.—A. S. T. M. Standard Method D–38–18. This is frequently designated in specifications for tar and tar derivatives as free carbon, although this is not in accord with the A. S. T. M. standard definition, which defines free carbon in tars as organic matter insoluble in carbon disulphide. The method referred to applies specifically to creosote oil. Where other tar products are being tested, it is recommended that two grams be used for the determination instead of 10 grams as specified.

Respectfully submitted,
FRANCIS P. SMITH, *Chairman*
M. S. EVANS
PREVOST HUBBARD
FELIX KLEEBERG

REPORT OF COMMITTEE ON STANDARD TESTS FOR NON-BITUMINOUS MATERIALS

Your Committee on "Standard Tests for Non-Bituminous Materials" herewith respectfully submits its 1921 Report.

Your Committee recommends that the Society adopt methods of testing non-bituminous materials which have given useful, satisfactory and reliable results. It further considers that it is highly desirable that methods of conducting different tests in different laboratories should be as uniform as possible. Hence, it is obvious that, as far as practicable, methods of testing adopted by national organizations should be identical. Based on the above hypotheses, your Committee has given careful consideration to the tests adopted by the American Society for Testing Materials, and those proposed by Committee C-9 on "Concrete and Concrete Aggregates" and Committee D-4 on "Standard Tests for Road and Paving Materials" of the American Society for Testing Materials and by the Special Committee on "Materials for Road Construction" of the American Society of Civil Engineers.

Your Committee recommends that the Society tentatively adopt, until the 1922 Convention, the following methods of testing:

Apparent specific gravity of sand, stone and slag screenings, and other fine non-bituminous highway materials, as described in the Am. Soc. Test. Mat., 1921 Standards, pages 715–718, and designated D 55–19.

Apparent specific gravity of coarse aggregates, as described in the Am. Soc. Test. Mat., 1921 Standards, pages 713, 714, and designated D 30–18.

Mechanical analysis of sand or other fine highway material, as described in the Am. Soc. Test. Mat., 1921 Standards, pages 721, 722, and designated D 7–18.

Mechanical analysis of mixture of sand or other fine material with broken stone or broken slag, as described in the Am. Soc. Test. Mat., 1921 Standards, page 724, and designated D 19–16.

Mechanical analysis of broken stone or broken slag, as described in the Am. Soc. Test. Mat., 1921 Standards, page 723, and designated D 18–16.

Abrasion of road material, as described in the Am. Soc. Test. Mat., 1921 Standards, page 710, and designated D 2–08.

Toughness of rock, as described in the Am. Soc. Test. Mat., 1921 Standards, pages 711, 712, and designated D 3–18.

Crushing strength of rock or slag, as described in the Am. Soc. C. E. Trans., Vol. 82, 1918, page 1442.

Cementation of rock, slag, and gravel powders, as described in the Am. Soc. C. E. Trans., Vol. 82, 1918, pages 1441, 1442.

Quantity of clay and silt in sand for highway construction, as described in the Am. Soc. Test. Mat., 1921 Standards, page 720, and designated D 74–21.

Quantity of clay and silt in gravel for highway construction, as described in the Am. Soc. Test. Mat., 1921 Standards, page 719, and designated D 72–21.

Organic impurities in sands for cement concrete, as described in the 1921 Report, Com. C–9, Am. Soc. Test. Mat., page 12, and designated C 40–21 T.

Tests for portland cement, as described in the Am. Soc. Test. Mat., 1921 Standards, pages 530–547, and designated C 9–21.

Workability of concrete for cement concrete pavements, as described in the Am. Soc. Test. Mat. Procs., Vol. 20, 1920, page 692, and designated D 62–20 T.

Compression test of cement concrete, as described in the 1921 Report, Com. C–9, Am. Soc. Test. Mat., pages 6–11, and designated C 39–21 T.

Paving brick rattler test, as described in the Am. Soc. Test. Mat., 1921 Standards, pages 567–574, and designated C 7–15.

Absorption of water by wood blocks after treatment, as described in the Am. Soc. C. E. Trans., Vol. 82, 1918, page 1447.

The Committee requests that all Specification Committees and members of the Society interested in tests for non-bituminous materials give careful consideration to the methods recommended and submit to the Chairman of the Committee, prior to July 1, 1922, criticisms and suggestions relative to the proposed methods of testing, in order that the next Convention may be in a position to adopt, as standards, methods of testing covering all test requirements included in the Society's specifications for non-bituminous materials.

Your Committee believes that the primary function of the Special Committee on "Standard Tests for Non-Bituminous Materials," is to serve the Society as a Committee to review new methods and modifications of present methods of testing non-bituminous materials and to recommend to the Society, from time to time, the adoption of standards and changes in such standards as may seem desirable.

Respectfully submitted,

ARTHUR H. BLANCHARD, *Chairman.*
THOMAS H. BRANNAN,
WALLACE L. CALDWELL,
AUSTIN B. FLETCHER,
CLARENCE D. POLLOCK.

REPORT OF COMMITTEE ON TRAFFIC AND TRANSPORTATION

Arthur H. Blanchard, Chairman, Ann Arbor, Mich.

Your Committee on Traffic and Transportation herewith respectfully submits its 1921 Report.

Investigations conducted during 1921 influence the Committee to strongly urge the general adoption, by municipal governments, of the recommendations embodied in its 1920 Report relative to the following subjects:

Use of "Dummy cops" at street intersections.

Installation of "rotary traffic" at street intersections wherever practicable.

Design and construction of long-radius curb corners.

Economic design of street widths on thru thorofares in small towns and cities.

Utilization of by-pass highways for towns and cities located on important national, state, and county trunk highways.

Consideration of the installation of motor-bus routes in municipalities, when an extension of the public passenger transportation system is required, in view of the resulting advantages of such installations from the standpoints of maintaining the maximum practicable traffic capacity of streets and of avoiding the use of car tracks in roadways.

Based on a careful analysis of public passenger transportation, your Committee considers that it is highly desirable, from the standpoints of economic public-service transportation and the efficient use of municipal streets by traffic, that the Society should strongly condemn the development of "wild cat" so called "jitney" service. Not only is the installation of such service undesirable from the standpoint of the overcrowding of streets with five-passenger public-transportation vehicles but it is obviously unfair to public-service corporations, operating under franchises, to be forced to compete with a "jitney" service which almost universally is operating on an uneconomic basis. The present overcrowding of some of the principal thorofares of the city of Detroit with hundreds of five-passenger "jitneys" furnishes a striking example of this type of public-service-transportation development.

Your Committee recommends that a highway transport division be installed in engineering or highway departments of municipalities having a population of over 100,000. The duties of this division would be to deal with all matters pertaining to traffic and transportation which affect the economic design and maintenance of streets and their efficient use by pedestrians and all classes of vehicles.

One of the important functions of such a division would be to make highway-transport surveys as preliminary to the design and re-design of streets, the determination of efficient methods of maintenance and the formulation of recommendations pertaining to efficient traffic regulations.

A highway-transport survey embodies all investigations in the field and office which are necessary to determine the probable amount, character and effects of the future traffic which will use a given highway during the lives of its several component parts. Such a survey for a given street may cover a consideration of all of the following factors: First, all highway elements which affect economic highway transport; second, legislation relative to franchises and rates, weights, dimensions and speeds of passenger cars, trucks, tractors, and trailers; third, state and urban traffic regulations; fourth, vehicular and population statistics; fifth, traffic censuses of motor and horse-drawn vehicles and cars operating on tracks; sixth, vehicular operation as affecting roadways and other parts of highways; seventh, present and future traffic and commercial-transport developments in such fields as agricultural and dairy farming, mines, quarries, gravel and sand pits, oil fields, lumber tracts, fisheries, plants, factories, wholesale and retail stores, parks and parkways, summer and amusement resorts, and real-estate improvements, which affect or will affect the traffic on the street under consideration; eighth, common carriers such as steam and electric railroads and waterway transportation companies and their relationship to street traffic; and ninth, the characteristics of the methods of highway transport such as street car, rural, interurban and urban motor-bus operation, municipal haulage, long and short general rural haulage, rural motor express, intercity haulage, intercity express, and horse transport.

Men assigned to a highway transport division should be experienced highway engineers who have acquired or are rapidly acquiring a knowledge of the following subjects: City-planning; highway transport economics, legislation, surveys and methods; highway transport management, including delivery systems, scheduling and routing; traffic regulations; interrelationship of highway, railway and waterway transport; port, terminal and warehouse facilities; and the fundamentals of the mechanism and operation of automobiles, motor trucks, tractors and trailers.

Your Committee has confined this report to two topics, namely, "jitney" transportation service and highway-transport divisions of engineering or highway departments, as it is hoped that this concentration will encourage members of the Society to thoroly discuss these important subjects during the meeting of the 1921 Convention.

DISCUSSION

Leon F. Peck: In Hartford there is evidence substantiating or backing up the recommendations of the Committee in reference to placing jitneys under the control of public service commissions.

Connecticut passed such a law and franchises may be granted by the public service commission. As a result of that the jitneys in Hartford were practically eliminated, and while at first there was a divided opinion among the population of Hartford I think now they are quite generally in favor of the jitneys being regulated by the public service commission.

GEN. J. A. P. JERVEY: In my town the jitneys are quite a serious menace to the local transportation by street cars, but they are giving service; the street-car company is not. The street-car company states that it is impossible to improve its service until the jitney is eliminated, but they don't offer any immediate substitute.

MR. BLANCHARD: I believe that, in such cases, the practice of the state of California should be followed, namely, that all intra-state transportation facilities should be placed under the control of a commission. The facilities of all steam and electric railroads, motor-bus companies, and rural and inter-city motor-express companies are investigated by this commission. If it is found that the facilities for passenger transportation are not adequate from the standpoint of service, franchises are then granted to motor bus companies.

In the case of jitneys operating in municipalities it seems only fair that they should be forced, under franchise, to give service on designated routes according to schedule, similar to that required of any other public-service-transportation corporation. The solution, in the city of General Jervey, is the granting of a franchise to a motor-bus company requiring the use of vehicles that are satisfactory for transportation purposes, which will operate on designated streets and which will give guaranteed service. If the costs of jitney service are analyzed, it will be found that invariably they are not operating on an economic basis, provided you consider all the factors which should be taken into account in a cost analysis of operation.

MR. WAHLQUIST: Where bus service is maintained and also rail service in a city, is it at all practical to have busses operating on the same streets where you have the car service on rails, or should they be on separate streets?

MR. BLANCHARD: I consider it highly uneconomical and undesirable to allow a motor-bus company to operate on the same street as a street-car corporation, provided that corporation is giving adequate service. Of course, it may not be practicable for the entire motor-bus route to be laid out without over-lapping streets with car lines. In cities like New York, it is hard to lay out a route where there will not be a little overlapping.

MR. MACGREGOR: New York has some other busses in addition to the main-line busses, which have taken the place of street-car lines which have gone out of operation. Some of the cross-town lines went out and busses have been substituted. Men from out of town should not be misled by statements in regard to the bus operation of New York City. It is largely a political question, but I must say there is a great need for the crosstown lines. I don't believe they serve the public as well as the street-car lines. The overhead trolley is forbidden in Manhattan.

MR. BLAIR: How are you going to contradistinguish between me, as a farmer, operating trucks, conveyances, over a road purely relating to my business for which I make no charge against any body else? How do you distinguish between a common carrier and individual operation for an individual's convenience?

MR. BLANCHARD: It appears to me that the individual operation is covered satisfactorily by the ordinary license laws, which are not by any means perfect or complete in many states. But in rendering service to the public, it is necessary to provide for a guaranteed service in respect not only to schedules and routes, but also with reference to the kind of vehicles used. Such service must be controlled in order to protect the public satisfactorily. I believe that Mr. Blair refers to the case of a factory, situated in a suburban district, which operates its own lines for its employees from the city to the suburban district. For the present, at least, the ordinary license provisions of legislation should cover such cases satisfactorily.

MR. NORTON: We have an outlying street which will soon become a main business thorofare. The cost of double-track construction will run somewhere between $100,000 and $150,000 a mile, making a burden upon that transportation company for a number of years, more than could be expected in returns. I would like to ask what the professor knows about the operation of bus service in such conditions where the traffic at present is not sufficient to support the overhead trolley. Also, has any city made a definite contract or charge rate for the use of the pavement? Third, does Professor Blanchard know anything about the danger of running on a new pavement with a trackless trolley?

MR. BLANCHARD: We find many examples in English cities of exactly the situation which you have outlined, namely, where the service does not warrant the installation of tracks and other overhead expenses and where motor-bus lines are developed to take care of that service. Of course, as motor-bus lines are flexible from the standpoint of the amount of service to be rendered, it is very easy to take care of a growing service economically. There is one development that has occurred in Great Britain which has not been used in this country to any extent, namely, the utilization of not only motor-bus lines but lines covering the transportation of freight installed and operated by and in connection with railroads. Such practice should include municipal street railways as well.

The charge for the use of the pavement is based, in English legislation, and should be based in all cases in this country, on an adequate return based on the wear of the pavement. There is a general agreement among motor-vehicle users that they are entirely willing to pay for the upkeep of pavements thru license fees or taxes. In many cases, I believe that our license fees or taxes are too small.

In regard to the trackless trolley, I admit I am not in favor of its general adoption. I do not believe, generally speaking, it is an economical and useful development in the case of extensions of street-railway service. The trackless trolley is very liable to do just exactly what Capt. Norton has mentioned, namely, to track and if they track, the tendency of course will be concentrated wear and the possibility of rutting of the pavement.

MR. HOWARD: As to the trackless trolley, you may be interested to know that in 1900 Paris, France, installed several in the Bois de Vincennes.

MR. RANKIN: It might be interesting for me to tell the story that was told me by a man who claimed to have seen the first jitney bus in the world. He was a United States commissioner in Barcelona, Spain, at the time of the World's Fair in that City a number of years ago. It was before the advent of the electric roads, and while cars were being operated by horses. I am telling this part to show that American politics are not the worst in the world. He said that an English company was organized for the purpose of building and operating a street-car line in Barcelona. It was first necessary to "see" the governing body, but after this had been properly taken care of the rest was easy and they secured a franchise giving them a monopoly of the street-railway business for the whole city. There was only one condition attached and that was that every street thru which their tracks were laid was to be paved from the rail to the curb with a smooth pavement of the very finest quality. The company accepted that provision, the tracks were laid, the streets were paved and the cars put in operation. The members of the Council then organized a bus company with the money which they had received for their votes and put on a line of busses in each street where the tracks had been put down and the smooth pavement laid, giving a little better service in time and taking on and discharging the passengers at the curb. Thus was the jitney born. The traction company soon went into the hands of a receiver.

MR. MULLEN: There is one point in favor of the bus line. I think if you will remember back in 1914 it was the busses of Paris which enabled the French Army command to resist the German advance. It could not have been done with street cars.

SUBWAYS FOR CITY TRANSPORTATION

By Robert Ridgway, Chief Engineer, Transit Commission, State of New York

Rapid transit systems for cities are comparatively modern institutions and are the result of the phenomenal growths of urban communities during the past 75 years. In the smaller cities of a century ago there was nothing in the conditions to require local rapid transit so, of course, no one gave much, if any, thought to the problems which were to vex the descendants of the more placid folks of those days except the few persons, always found in every community, who are gifted with a far-seeing vision into the future. Merchants and other business men of the small town or village of the past lived within walking distance of their shops and offices. This, of course, was before the days of the automobile. As the community grew in size and the distance between home and office became too great to walk morning and evening, tram cars and omnibuses were considered sufficient to take care of the transit needs. The trend to the cities resulted in the wonderful growths indicated by the census figures of the past eight or ten decades and then the question of rapid transit began to be discussed. New York, being the largest of our American cities, naturally felt the urge first and soon after the ending of the War between the States the agitation began which still continues and which, on account of its importance to the people, has often been made the political issue of municipal campaigns. It is one of the leading issues at the present time and has been and is being widely discussed from every possible point of view. The opinions expressed by different authorities having to do with the question are wide apart and fundamentally opposite. The inherent difficulties of the situation are increased and the task of those who are honestly striving for a correct solution of the problem is greatly magnified by destructive opposition which is advanced when anything is put forth. However, right usually prevails and destructive opposition must in the long run give way to reason, sanity and common sense.

Every man is intensely interested in the local transit facilities of his city because they affect his comfort and convenience so intimately and because any of their defects or shortcomings are so apparent to him. He remembers that he had to wait for his subway train and was obliged to stand in discomfort all the way home when he ought to have had a seat. Water supply and sewerage, while quite as important to his well-being, have a relatively mild interest for him so long as the sewer does not become choked and back up into his cellar and the wholesome water flows when the faucet is turned. The water supply structures and the sewers are out of his sight and he does not think of them until they fail to function properly. Few citizens think of what they cost or whether they are well designed and honestly constructed.

If the transit system of a city could be established before the population arrived the city-plan would in many cases be very different from what it now is. Whether better or worse would, of course, depend upon the wisdom and far-sightedness of those who did the planning, but it is impossible to look far into the future or to foresee the advance in the art of construction and the revolutionary changes which take place from time to time in the methods of transportation. Who in New York a century ago would have believed that the wide river separating Manhattan Island from Long Island would be bridged and tunneled as it has been since that time or that electrical traction would have been developed to the state it has reached to-day? I am afraid if an attempt had then been made to lay out a rapid transit system to fit our present needs the experts would have made a sad mess of it because they would have had to deal with too many unknown factors. It is not wise to design transportation systems or other utilities for the needs of a time too far ahead. Railway structures and equipment, like battleships, become obsolete and then in part at least are liabilities rather than assets, except the right of way, which in nearly every case retains and generally increases in

PLATE I. *Modern Elevated Railway, Showing Station Platforms and track, (99% completed)*

value. In constructing the subway in lower Broadway, New York, in 1912, there was uncovered the short stretch of rapid transit tunnel constructed 40 years before, which was known as the Beach tunnel. This was a tube only nine feet in diameter which the promoters of the scheme thought to be adequate for rapid transit purpose but which would hardly be seriously considered to-day as of much use for that purpose. Those pioneer tubes of the underground system of London which were constructed many years ago of small diameter, while they are successfully operated in spite of their limited size, those who so ably manage the system would not think of duplicating such structures to-day.

When a city reaches the stage of growth that a rapid transit system is necessary to its proper development and well-being it becomes a question as to what type is the best one suited for its ends—whether the railways will be on the surface at street grades, whether elevated on steel or masonry structures or on embankments or whether they will take the form of underground lines either in open cuts, shallow cut-and-cover subways or deep tunnels.

A rapid-transit railroad at street grade is dangerous, is an obstruction to other traffic and should not be tolerated in any city except as a last resort. About the only argument in its favor is cheapness of construction but in every other way it is expensive and unsatisfactory and its service is subject to much interference and many delays.

Elevated railroads are far preferable to surface lines for obvious reasons, but they are noisy in operation, they obstruct the street to a greater or lesser degree and are often unsightly. The objection to them is somewhat reduced if they are located on private rights of way between the streets but this adds materially to their cost and in most cases the real estate values are so high as to make such a location prohibitive. Some of the European cities have been successful in designing structures less objectionable from an aesthetic point of view than those we are accustomed to see on this side of the water. The elevated railroad in our cities usually takes the form of a steel viaduct.

In New York the standard type of the city-owned elevated lines recently built is shown on Plate No. I, with variations in details to fit local conditions and requirements. The structure is much stronger and heavier, of course, than those built by the private companies from 30 to 50 years ago, on account of the increased weight of the modern rolling stock. The track floor is not of the solid type planned for the Frankford line in Philadelphia which, by the way, adds to the cost of construction, but the ties are laid on and attached to the longitudinal stringers of the structure, this being the general practice in New York and some other American cities. A masonry or re-inforced concrete structure, while less objectionable from an aesthetic standpoint, is more expensive to build than a steel viaduct. An example of

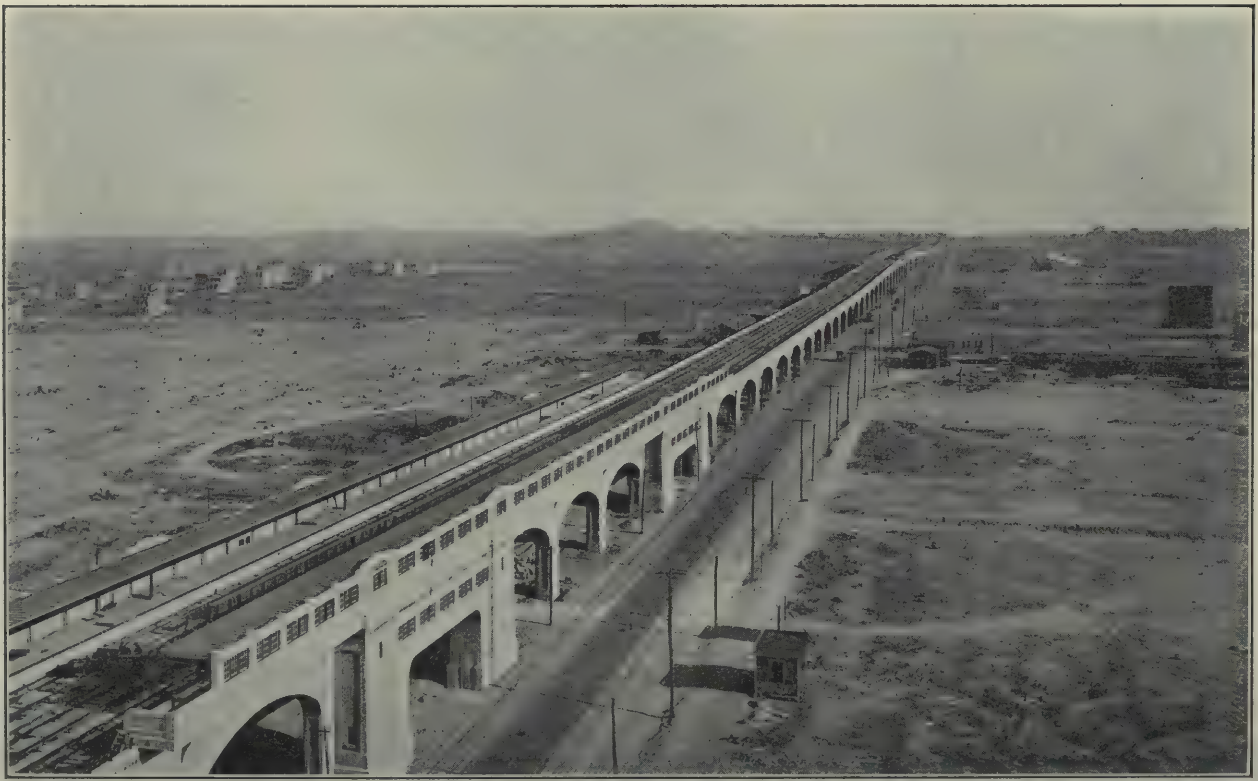

PLATE II. *Modern Concrete Three-Track Elevated Line of the Corona Branch, Boro of Queens, New York City*

such a concrete viaduct is shown on Plate No. II. This is part of the three-track elevated line of the Corona Branch in the Boro of Queens, New York City, which for a length of 4,300 feet is located on Queens Boulevard, a thorofare 200 feet wide, which is to be developed as an attractive parkway. A steel structure was properly regarded as being objectionable for such a location. The concrete surfaces of this viaduct are tooled and decorated with colored tiles and the effect is quite pleasing. However, while such a structure is in thoro keeping with the conditions at this location and is well adapted for wide parkways and large spaces, it cannot be recommended for use in ordinary city streets where its lines could not be seen to advantage and where its massive structure would obstruct traffic and darken the streets. Where the steel viaducts of the elevated lines cross parkways and in certain other special locations, it has been the practice of the past ten years to encase the steel members of the structure in concrete, the surfaces of which are also tooled and decorated with colored tiles. An example of such treatment is shown in Plate III.

An earth embankment or an open cut is generally not feasible in congested parts of a city but has been successfully used in the outlying portions where property values and traffic are not so great. Examples may be seen in some of the European cities. Plate No. IV, shows an open cut of one of the lines of the New York Municipal Railway Corporation system in South Brooklyn. Several of their lines operate in open cuts like this. They are located on the private rights of way of steam roads, the original tracks of which were mainly on the surface. The sides of the cuts are sloped and grassed or held by concrete retaining walls. It is possible to roof over the tracks in the future if it is desirable to do so. This form of construction has many advantages but is only practicable where there is a private right of way or where the street is exceptionally wide. It would never do for the downtown section of a city unless there was already in existence a private right of way available for it. Its cost is greater than that of an elevated road of the usual type.

Subways have the great advantage of being out of sight. After they are built they permit the streets under which they ran to be used to the fullest extent. Operation in them is noiseless to those on or above the street surface and they do not obstruct light, air or access to property. While it is not as pleasant to travel below ground as above it, train operation in subways is not affected by weather conditions and when the stations are located at shallow depths they are very convenient of access, more than the other types described. Subways have the effect of materially enhancing real estate values in the portions of the city they serve, particularly in the vicinity of the stations. The principal argument against them is the cost which, from New York's experience, is from four to five times that of a steel elevated railroad of the same capacity. Prior to the War, New York's subways cost to construct, including track, stations and other

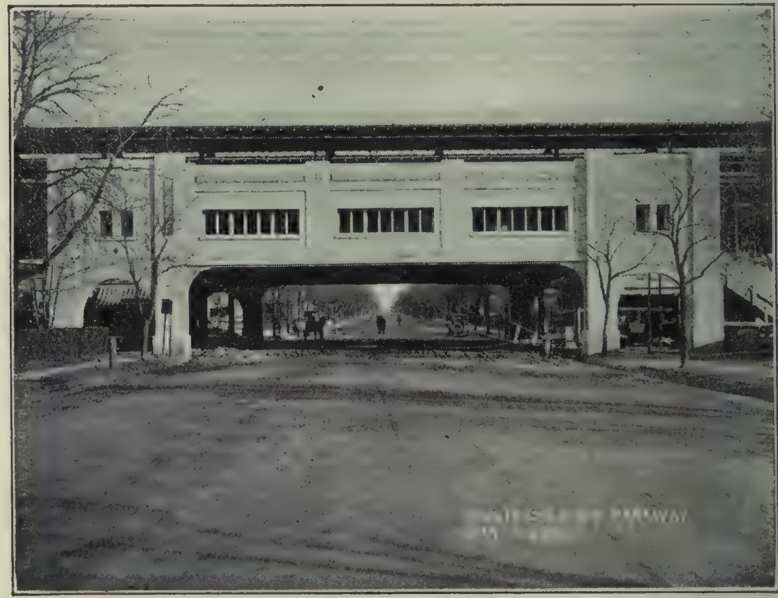

Plate III. *Concrete Type of Elevated Railway Station. Bay Parkway Station*

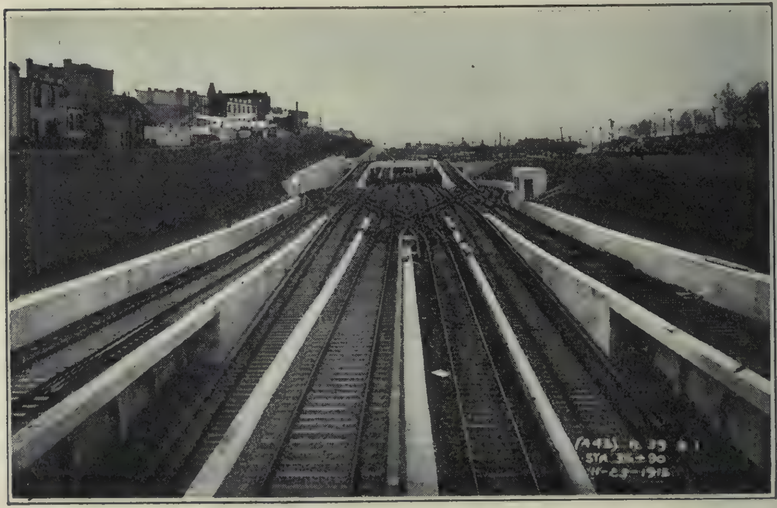

Plate IV. *Open Cut Rapid-Transit Railway. Culver Line Depressed Tracks*

appurtenant work and including also the maintenance and underpinning of abutting buildings and the maintenance and restoration or reconstruction of surface and subsurface utilities but excluding the furnishing and installation of third rail, signals, lights and other equipment, from $700,000 per track mile in an outlying portion of Brooklyn to $2,500,000 per track mile in a very congested section of lower Manhattan. Similar costs at pre-war prices for a steel elevated railroad were about $275,000 per track mile for a three-track line and about $235,000 per track mile for a two-track line. These costs would be much greater at the present time. To put it in another way: a given amount of money for rapid transit construction would build from four to five times as much elevated line as subway.

With these facts in mind it would seem that subways, notwithstanding their many advantages, must be confined to the congested portions of a city, using elevated structures or open cuts for the extensions into the less congested and outlying parts. It is a fact that other considerations than financial ones sometimes govern. For instance, an elevated railroad could be constructed in the narrow street of the most intensely used business section of a city for a fraction of the cost of a subway but public opinion might not permit it to be built there and might insist upon having the subway notwithstanding the much higher cost.

Subways for local transportation are a development of the present generation. The pioneer subways were built only a quarter of a century ago. The conservative minds of the preceding generation doubted if it was practicable to construct them and the feeling at that time may be illustrated by this extract from the New York Herald of January 25, 1866, regarding an underground railroad then proposed for lower Manhattan:

"Say these capitalists, spend five or six millions in this preposterous scheme! So much the better. It will thus be drawn from their plethoric coffers and distributed among the community! The employment for laborers will be immense. Labor will be in demand, and it will be kept here. Say a few buildings crack their sides, as if shaken by an earthquake, and tumble down. So be it. These capitalists can pay the damage, and the greater the destruction, the more employment for our masons, carpenters, laborers, etc. Suppose the miasma arising from the vent-holes necessarily opened during the excavation of this tunnel breed a pestilence; still, alas! so much the better for our physicians, who can not find sufficient employment with five hundred deaths weekly on the City Inspector's report as evidence of the sanitary condition of our city! So go ahead, underground railroad directors! Bring out your dollars, spend them liberally, and if you do smash up, you are better able to stand a crash than others who have less money, but perhaps more judgment!"

Few cities have subways, largely because they are so costly to build. New York, I believe, has a greater mileage of them than all other cities of the world combined, because conditions there are such as to make subways necessary for the large, intensively developed areas. Every city has its own problem of local transportation and while general principles must apply to the solution, each problem should be carefully studied in all its aspects before a decision is reached. The expenditures involved are so large and the consequences of a wrong decision may be so deplorable that no snap judgment should be taken.

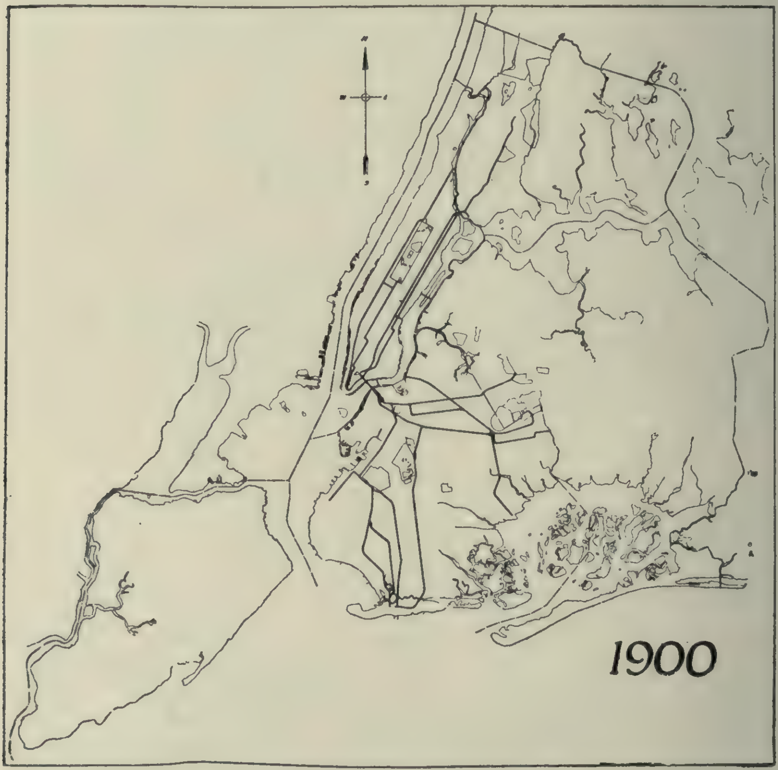

PLATE V. *Outline Map Showing Rapid Transit in Greater New York, in 1900, Before Subways Were Built*

As the speaker has been connected with the rapid transit construction of New York for many years, you may be interested in hearing him describe some of the work there, particularly certain features of the construction which has been carried to completion within the past 10 years.

The following table gives the area of each boro of the City of New York, its population according to the United States census of 1920, the approximate density of population and the assessed valuation of real and personal property as of 1921:

Boro	Sq. Miles	1920 Population	1920 Density per Acre	1921 Assessed Valuation—Real and Personal Property
Manhattan	22	2,284,103	162.2	$6,031,590,233
Brooklyn	81	2,022,262	39.0	2,433,228,323
Bronx	39	732,016	29.3	866,347,103
Queens	121	466,811	6.0	726,227,489
Richmond	57	115,959	3.2	128,814,131
New York City	320	5,621,151	27.44	$10,186,207,279

In 1898, when consolidation of the five boros forming the present city was effected, the rapid transit systems of the Greater City consisted of the

(1) Four north-and-south elevated lines of the Manhattan Railway Company, known as the Second, Third, Sixth, and Ninth Avenues Lines with a branch extending north into the Boro of The Bronx. These lines included a single-track mileage of about 92 miles and a route mileage of about 37 miles, shown on Plate V.

(2) The several radiating elevated lines in the boro of Brooklyn, also shown on Plate No. V, which later formed the system known as the Brooklyn Rapid Transit Company, with a track mileage of about 101 and a route mileage of about 45.

All of these lines were originally double-track. A third track had been added to portions of the Third and Ninth Avenues Lines in Manhattan to permit express service south during the morning and north during the evening rush hours.

In 1900, the city by the Rapid Transit Railroad Commissioners began the construction of the first subway to be municipally owned and to be privately operated under a lease running 50 years with a provision for a 25-year renewal. This line, known as Contract No. 1, consisted of a four-track trunk, with the two middle tracks for express service, extending from the post-office building at the junction of Park Row and Broadway in lower Manhattan north to the Grand Central Terminal of the New York Central Lines, thence west under 42nd Street to Broadway and north under that thorofare to 96th Street, from which point two two-track branches extended the line to Bronx Park and to Van Cortlandt Park in the boro of the Bronx. The outlying portions of the two branches were elevated structures.

In 1902, Contract 2 was let for a two-track extension of the line south from the post office under Broadway to Battery Park, thence under the East River and the streets of Brooklyn to a terminus at the passenger station of the Long Island Railroad at the junction of Flatbush and Atlantic Avenues. The lease for Contract No. 2 was for a term of 35 years.

Operation was begun in October, 1904, in the first portion to be completed and was extended from time to time until, in 1908, Contracts 1 and 2 were in full operation. With the elevated lines of the Manhattan Railway Company, taken over in 1902 by a long term lease, they formed the operating system of the Interborough Rapid Transit Company.

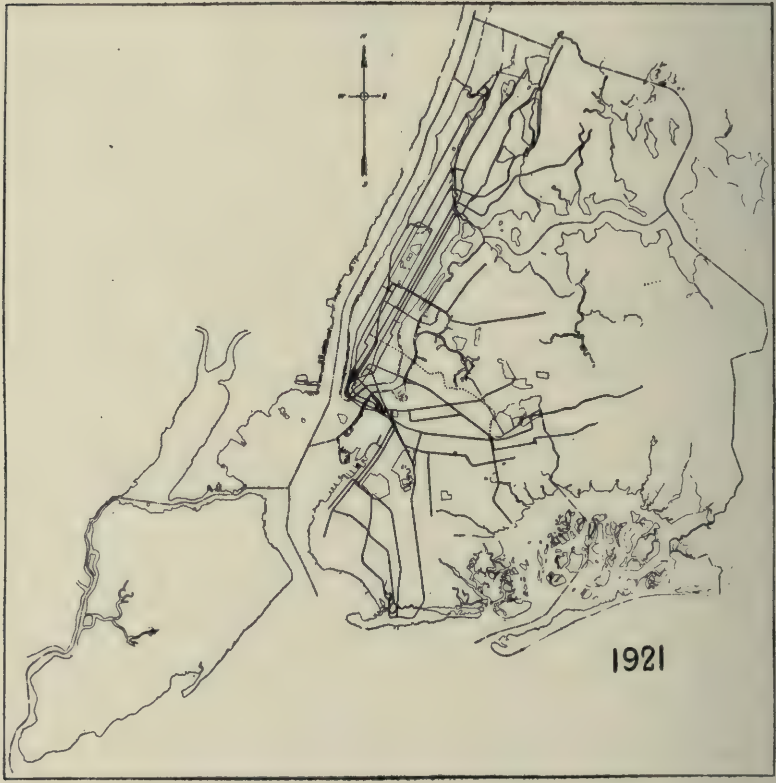

PLATE VI. *Outline Map Showing Rapid Transit in Greater New York in 1921*

Meanwhile, the enactment of legislation at Albany in 1906, which forbid the leasing and operation of other city-owned lines for a longer period than 20 years with one renewal of 20 years, effectually stopped the building of additional subways under contracts similar to those of Nos. 1 and 2. Between 1907 and 1912, however, the city did undertake the construction of additional subways intended to form parts of separate systems. After they were constructed they were taken into the Dual System which will be described later and they were not operated until then. As time went on the need for more rapid transit was increasingly felt and the demands for relief became more insistent.

On March 19, 1913, after a long period of negotiations, Contracts 3 and 4 were entered into by the City, acting by the Public Service Commission for the First District, with the Interborough Rapid Transit Company for Contract 3 and with the New York Municipal Railway Corporation, formed by the Brooklyn Rapid Transit Company for the purpose, for Contract 4. These two contracts, called the Dual Contracts, provided for taking into the new systems the then operating lines of the Interborough Rapid Transit and the Brooklyn Rapid Transit systems including the city-owned subway of the Interborough system, the extension and improvement of those lines, the construction of many new lines, subway and elevated, the equipment of the enlarged systems and their operation for a term of 49 years. The two Companies were to pay all the cost of equipment and of the improvements and extensions of their privately-owned lines. They were also to contribute specified sums to the cost of the construction of the city-owned lines, $59,000,000 in the case of the Inter-borough Rapid Transit Company and $13,500,000 in the case of the New York Municipal Railway Corporation. The receipts from the existing and new lines of each system were to be pooled and after operating expenses were met the Companies and then the City were to deduct certain charges, in the order named in the Contracts, (deficits to be cumulative), the balance, if any, to be divided equally between them. A five-cent fare is specified.

It is not within the purview of this paper to go into the details of these contracts, which are of such importance to New York City and which have been and are being discussed so much, both favorably and otherwise. It is of interest, however, to know that the cost of constructing the Dual System will be, when completed, over $400,000,000 and of equipping the lines and improving and extending the Companies' own lines over $180,000,000. These costs include the city-owned lines built between 1900 and 1913, but do not include the extensive companies-owned lines constructed prior to 1913. About one-quarter of the construction cost and all of the equipment cost are borne by the two operating companies and the two systems will include, when completed, approximately 70 miles of subway, 17 miles of railroad in open cut below street grades and on embankment, 126 miles of steel and concrete viaducts and bridges, a total of 213 miles of railroad and 619 miles of single running track. All but 10 miles of this total mileage of railroad is in operation.

At the time the construction of the first subway was undertaken in 1900, public opinion had determined that no more elevated structures like those of the Manhattan and Brooklyn Rapid Transit Systems should be built in the congested sections of the City and that feeling is stronger now than it was then. Consequently, the policy has been established that in such sections as those of central and southern Manhattan and in down-town Brooklyn the subway type must be used in spite of its high cost and the inconvenience caused while it is being built. The conditions in those portions of the city justify this course.

The many office and loft buildings of the skyscraper type in the financial, commercial and industrial center, south of 59th Street, Manhattan, the large and intensively used amusement, hotel and shopping districts in central Manhattan and the extensive areas occupied by large apartment houses in central and upper Manhattan all contribute to make subways not only desirable but in normal times profitable, notwithstanding the large investment they represent. The same considerations apply to a portion of down-town Brooklyn. There are few, if any, places in the world where there is this concentration of business, resident and amusement interests. The Equitable Building, 40 stories high, in lower Broadway, is believed to be the largest office building in the world and houses about 13,000 tenants and employees on business days. The Woolworth Building and the Metropolitan Life Building each house about 12,000 and the Hudson Terminal Building about 10,000. These stand out among the larger office buildings but there are many others in each of which there are thousands of workers. Few of the apartment houses in Manhattan are less than five stories in height and many of them are higher. It may be said that the one-family private dwelling is no longer being built in Manhattan and those which now exist are being gradually replaced by apartment houses. The hotels of Manhattan including apartment hotels are about 120 in number and, excluding the moving picture and vaudeville houses, there are about 100 theaters in the boro. With nearly everybody quitting work at the same hour the evening peak load of travel is very sharp and is the cause of most of the crowding of which complaint is made. Those of you who have attempted to board a New York subway train at about 5:30 p. m. will realize something of what the problem is. The number of passengers carried by the Dual System, that is, the rapid transit lines, for the year ended June 30, 1921, amounted to over 1,418,000,000. The average on business days is about 4,172,500 and the maximum for one day was about 4,929,000.* These figures are exclusive of the passengers carried by the surface lines, the bus lines and the suburban services of the trunk-line railroads. The following table indicates the ticket sales at some of the more important subway stations of the congested zone:

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* This occurred in February, 1920, on the occasion of a snow-storm partially tying up surface-car traffic, which increased subway traffic.

Annual Ticket Sales for year Ended June 30, 1921
Interborough Rapid Transit Co.

BORO OF MANHATTAN

Portion of original subway on lower Broadway and Fourth Ave.—now part of the new Lexington Ave. Line		New Seventh Ave. Line	
Stations	*No. of tickets sold*	*Stations*	*No. of tickets sold*
South Ferry Station	1,732,200	Wall St	9,584,100
Bowling Green	6,961,700	Fulton St	4,190,210
Wall St	9,435,100	Park Place	4,525,800
Fulton St	14,803,100	Chambers St	6,487,500
Brooklyn Bridge	15,238,000	14th St	10,093,000
14th St	15,862,000	34th St. (Penn. Sta.)	23,071,850
42nd St. (Grand Central)	28,970,900	42nd St. (Times Sq.)	29,568,260

BORO OF BROOKLYN

Boro Hall	9,945,100
Atlantic Ave	19,929,720

The intensively developed portion of New York is beyond question on a subway district but the roads are taken out of the ground as the outlying or less congested portions of the city are reached and the extensions are carried on elevated structures.

Compared with subways, elevated railroads are simple to construct and can be built in far less time. In normal times, an elevated structure can be finished ready for track in from 18 to 24 months of the date when work in the field is begun and the discomfort to the public and interference with traffic on account of the construction, is confined to a small part of this period. The disturbance of the street surface and of the utilities underlying it is relatively slight. With a section of a subway, on the other hand, from three to four years' time is usually required for construction and, except where it is at such depth that the work is done by tunneling methods, it requires generally the entire reconstruction of the street and of the sewers, water and gas mains and other structures beneath it. In other words, the task is not only to dig a trench and build a subway therein but also to support the decking forming the temporary street surface, the car lines, elevated railroads and other structures which may be on or above the surface together with all of the sewers, water, gas and steam mains, the ducts carrying the power, light and telephone cables and the other utilities which exist for the comfort and convenience of a modern city. Frequently, in addition to maintaining these utilities for their usual service during the construction period, it is necessary on account of their interference with the subway structure, to rebuild or relay them in other than their original locations when the time comes to restore the street surface.

The importance of this work will be understood when it is stated that an estimate made a few years ago indicated that the potential power transmitted thru the water, gas, steam and electric power mains underlying the streets of New York City was three times the power then being generated by all the hydro-electric plants on both sides of the Niagara River. Abutting buildings must be supported and protected against settlement or collapse and, in many cases, their foundations must be carried down to greater depths. The cost of this incidental work is enormous and in accordance with the Rapid Transit Act under which the New York subways are built it is a charge against the rapid transit account. All of this maintenance, restoration and reconstruction must be done thoroly and every care taken to avoid accident, because a failure means at least an interruption of the service of some important utility on which the health, convenience or comfort of so many may depend. Some times a failure means damage to property or loss of life. The danger of a catastrophe occurring is always present and the responsibility of the engineers in charge and of the contractor is heavy. To remove the hazard of explosion no live gas mains are permitted under the street decking, temporary mains for service being maintained on the street surface or above it on trestles.

In the case of the contract for a two-track subway in a narrow street in lower Manhattan the cost of underpinning the abutting buildings amounted to about one-third of the total cost of the contract. One of the structures on the line of this contract was a 20-story office building, the foundations of which rested on quick sand and projected 9 feet into the street, occupying space needed for the subway. It was necessary to carry these foundations down 15 feet or more below their former level so as to secure the buildings and to permit the subway to be built. Hundreds of buildings, large and small, were underpinned and new and ingenious methods were developed for doing this work by the contractors and their engineers. In several instances it was necessary to carry the subways under high buildings. The most notable instance of this was the construction of a two-track subway directly under the United States Post Office, a massive five-story granite building of the old-fashioned type which occupies a triangular plot between Broadway and Park Row. The subgrade of the subway was 25 feet below the foundations of the building in water-bearing sand. This work was carried on with great care and skill on the part of the contractor and his engineer and it was successfully completed without interference with the occupancy of the building except a small portion of the subbasement, which was occupied by the contractor in connection with construction operations. The loads carried by 53 columns and 10 piers, amounting to 27,000 tons, were transferred to lower levels below subgrade or to the subway roof. The maximum load for one pier was 1,100 tons and the average for all was about 430 tons. The underpinning of the large buildings along the line of the work caused little or no interference with their use by the tenants. In fact, many of the latter probably had no knowledge that any such work was going on.

An analysis of 57 subway contracts showed the total expenditures on account of them to have been distributed as follows:

Item of Work	*Percentage of Cost*
Earth excavation	25.6%
Rock excavation	15.9%
Concrete	14.0%
Riveted steel, furnished and erected	7.4%
Rolled steel, furnished and erected	7.2%
Steel rods, furnished and erected	1.0%
Underpinning buildings	6.5%
Supporting existing railroads	2.7%
Construction of new sewers	3.8%
Relocating pipes and ducts in street	2.8%
Waterproofing, railroad ducts and miscellaneous work	13.1%
Total	100.00%

The design of a subway must take into account, among other things, the geological conditions, the location of the rock, if any, the character of the soft ground, the presence or absence of ground water, the widths of the street and the character of the buildings abutting on them, the character, size and number of the subsurface utilities, the surface tracks and the elevated railroads, if any, the depth to which the subway must be placed to cross over or under or to join other subways already constructed or to be constructed. Careful surveys must be made showing all of the conditions, reference points and bench marks established, borings made, the surface, subsurface and overhead structures located and plotted, notes made of the condition of pavements, sidewalks, buildings and other structures, record photographs taken and much other work of a similar character must be done before the designs are made and construction begun. The location of local and express stations must be determined and their means of entrance and exit studied. Within reasonable limits, the more carefully and accurately such work is done the better will be the design and construction of the subways and the more economical and better their maintenance and operation.

The geological conditions have an important influence on the design. Rock is generally found at the subway depths in The Bronx and in Manhattan north of 8th street, and also at the extreme southerly end. Between 8th Street and the Battery, including the downtown skyscraper district, the rock surface falls to a maximum depth of over 100 feet below the street grade and the workings were often in fine wet sand of the character of quicksand. In Brooklyn and in Queens, except near the river shore of the latter boro, the rock lies at depths far below the subway workings.

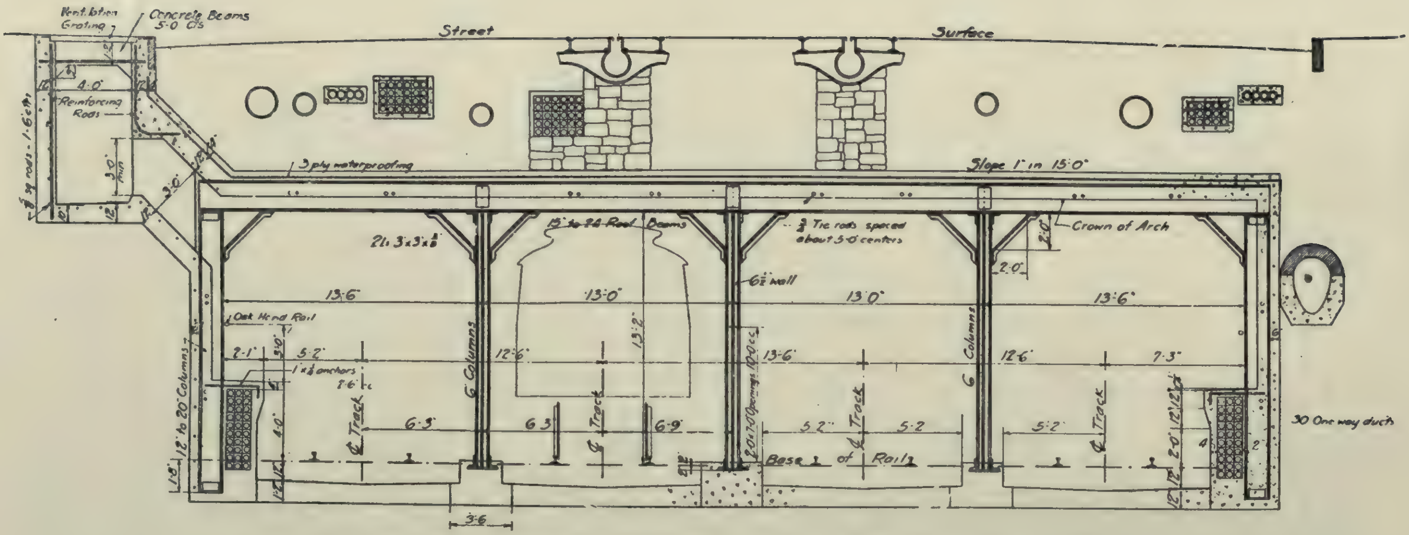

Plate VII. *Standard Form of Cut-and-Cover Four-Track Subway under Normal Conditions*

New York's subways differ from those of other cities in that their trunk lines provide for express as well as local service in both directions. This means that four or more tracks are required. The standard form of the cut-and-cover four-track subway where the conditions are normal is shown on Plate No. VII. Steel bents spaced generally five feet apart on centers are made up of I-beam side columns, built-up interior columns and I-beam or girder roof members. The floor is of concrete, re-inforced with steel where necessary, and concrete jack-arch sidewalls and roof fill the spaces between the bents. The roof and sidewalls, and under some conditions the floor, are waterproofed at stations as is the roof between stations and also such other parts of the structure as are below ground water. The waterproofing consists of a membrane of coal tar pitch and burlap where there is little or no head of water and of bricks laid in mastic where the water pressures are greater. The power and other cables are carried in ducts laid inside of the structure and the ducts are enclosed in concrete, the top of which covering forms a walk, about at the level of the car floor, which can be used by passengers in case of accident. Provision is made for draining any seepage into the sewers where the latter are below the grade of the floor or, where the subway is below the sewer grade, into sumps at low points of the grades, from which the water is lifted to the sewers by pumping. Half way between stations are emergency exits equipped with stairways leading to the sidewalks, and ventilation chambers discharging the air thru gratings set in the sidewalk. The ventilation chambers with their fan equipment are designed to provide for a renewal of air in the subway between the stations in from 10 to 25 minutes.

The height from the base of rail to the roof is 13 feet, 2 inches and the track centers are 12 feet, 6 inches apart in the Interborough and 13 feet, 6 inches apart in the Municipal Corporation Subway. The trackways of the latter company's subways are made wider because its car is 10 feet wide while the Interborough car is 9 feet wide. The track is of the tie and ballast type except at stations and in some of the river tunnels, where a solid type is used, that is, short ties bedded in concrete with an open ditch or drain between the rails. Every fourth or fifth tie is a long one to support the third or power rail. Generally, the relocated sewers are built alongside of and in contact with the walls of the subway. The yokes of the surface of the underground conduit systems are supported on masonry piers carried up from the subway roof. Provision is made in the design to take care of unusual or concentrated loads, such as elevated railroad columns. Where the subway is on private property, the structure is designed to carry present or future buildings up to a maximum height of 25 stories.

The foregoing describes only the general features of the normal type of subway. There are many variations from this types. Re-inforced concrete has been and is still being used to some extent where the local conditions make it advisable to do so, but the steel-bent type of structure is considered to be more practicable for use in crowded cities because the overhead loads and side pressures can be transferred to the steel frame as soon as it is erected and riveted, whereas with re-inforced concrete, a sufficient time must be allowed for setting up before such loads can be applied.

Sometimes, the structure is forced to unusual depths by the profile of the street or by the necessity of crossing under existing subways and other structures, in which case the design is modified to take care of the increased loads. Many miles of subway are in deep tunnel for a considerable distance. For a considerable distance under Lexington Avenue, Manhattan, the two local tracks were built by the cut and cover method near the street surface at a minimum depth below the street surface while the two express tracks were in tunnel far below them. Sometimes, the structure takes the form of a double-deck tunnel or a double-deck cut and cover section. Two-track or four-track structures predominate but in special cases for short distances there are from one to eight tracks. Plate No. VIII, is a diagram showing the different types of subway structures built as parts of the Dual System and it indicates the great variety of conditions encountered and gives one an idea of the complicated nature and magnitude of the engineering problems involved in the work. Almost every condition that one might expect to encounter in such construction has been successfully met.

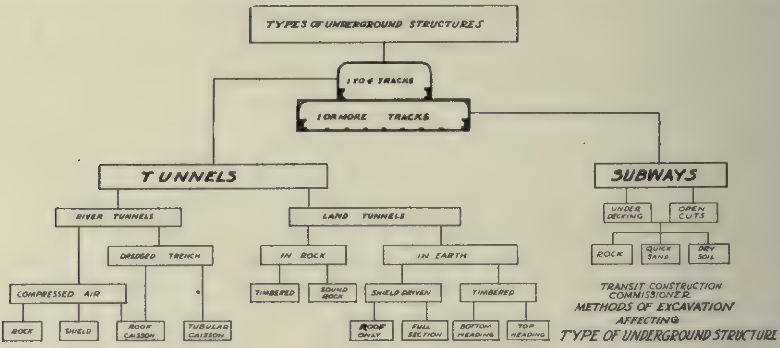

PLATE VIII

The diagram also shows the types of the eight tunnels constructed under the East and Harlem Rivers but no other mention will be made of them here as they are special features of New York's problem. To go into the details of these and other special features of the work would require far more time than is available to-day.

The stations are of the local and express types. The local stations are located from ¼ to ½ mile apart and the express stations usually at longer intervals—generally from 1½ to 2 miles apart. The typical local station has side platforms and those of the express stations are usually between the local and express tracks. In the Interborough Subway, the platforms of the express stations are about 480 feet long to accommodate their ten-car trains, the cars of which are 51 feet, 2 inches long. The platforms of the original local stations now accommodate six-car trains while those constructed within the past ten years are designed for the full ten-car trains. The cars of the Municipal Railway Corporation are 66 feet long and the platforms of their local and express stations are now made 530 feet long to accommodate eight-car trains.

The city-owned subways were built under construction contracts prepared by the Commission's engineering force and the construction was supervised by it. The work, exclusive of Contracts 1 and 2, was divided into 87 construction contracts, in addition to which there were many other construction contracts for Track Work, Station Finish, Yards, Shops and miscellaneous work. The construction contracts varied from about $500,000 to $6,000,000 in value. Prior to 1912, the lump sum form of contract was used, but, since then, the unit-price form has been employed except in a few special cases.

The work in connection with the design and construction of New York's subways has been thus referred to briefly in order to give an idea of the problem there. The work there has been so vast and of such a complicated nature that it is not possible here to refer to it except in this general way. Enough has been said to indicate that a rapid transit subway is an expensive structure to build and that it can only be financially justified where there are conditions of congestion such as those present in New York and in the concentrated business districts of some other cities. It should be remembered, however, that other considerations than those of direct financial return are sometimes predominant, and, that for broader reasons, a subway would be justified in certain sections of the larger cities as a part of any rapid transit system that is to be developed.

THE PORT AND THE MUNICIPALITY

By J. E. Greiner, Chairman of Port Development Commission of Baltimore

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Mechanism and Organism

When we analyze the influences which make a port and a city going concerns we must get away from the idea that a port is simply a place where ships load and unload, and the municipality a place where people work and live. We should vision the port and the municipality, not as places, but the one as a mechanism functioning with the object of accomplishing the economical interchange of freight between the land and water carriers, and the other as an organism functioning with the object of improving the public welfare. With such a conception before us we see on one side terminals, trains, ships, freight; and on the other, city executives, business associations, improvement societies, aspirations.

Measure of Commerce

So long as the main objective of the municipal organism is public welfare—prosperity, improvement, growth,—one of the surest ways of accomplishing this objective in a seaboard city is to produce the commerce which is to be handled by the port, but it should be remembered that the port mechanism thru which this commerce must pass is a measure of the volume of the commerce, because no matter how much freight is produced, no matter how many carriers are available, no more freight can be transferred from the one to the other than can pass thru the gateway of the port. It thus appears that if in a seaboard town the amount of commerce is a measure of municipal prosperity and is at the same time limited by the capacity of the port, then the port itself is not only a measure of the amount of commerce, but also of the municipal welfare.

Therefore it may be stated as a general proposition that the greatest asset of a seaboard city is its port. The city will become great as the port becomes great, and the success of both port and city will depend largely upon the push, the enterprise, the broad vision of the municipal organism and its willingness to look beyond the horizon of immediate personal affairs and to work for the common good.

Sugar Refinery

We have a striking illustration here in Baltimore of the effects of the activities of her municipal organism. On the south side of our inner harbor a great sugar refinery is nearing completion. It is the largest in the world. For the port that refinery means almost a ship load and 70 car loads of sugar every day. For the city it means the investment of millions, the increasing of the taxable basis, employment of labor, furnishing of supplies. The ramifications of this one enterprise will reach thruout the city with its benefits. This refinery would not have come to Baltimore if her port had not been ample; it would not have come no matter how excellent the port facilities unless the city itself had been able to furnish it with the labor and supplies which it requires; it probably would not have come even with all that the port and city could supply if in the first place its interest had not been stimulated by the activities of the municipal organism thru port pamphlets and personal contact.

Grain Exporters

In contrast with the above illustration there might be cited the action of certain Baltimore grain exporters who are enthusiastic for the port so long as their enthusiasm costs them nothing but words. They are quite ready to advocate improvements and developments for the purpose of handling their special exports, but when these facilities are supplied, they do not hesitate to ship thru a port on the Gulf when the manipulation of freight rates thru the favoritism of the Government saves them a few cents a bushel on their grain. Of course this is business, and it is human nature for some near-sighted business men to regard the future of the municipality and the port as of minor consideration when compared with their immediate profits.

Change in Policy

No municipality that wants to be considered alive or wants to prosper can afford to neglect its port. The port's development should be the first concern. We now realize this in Baltimore. We, as a municipality, allowed things to drift for many years, and depended upon our natural advantages and the railroad terminals while rival ports were developing along modern lines. We have quit that policy and are now active in our preparations for most radical improvements.

Essentials

But recognition by the city authorities of the importance of the port and their willingness to work wholeheartedly for the port's development, combined with the enthusiastic backing of the business interests of the city, while necessary for port development are not in themselves sufficient for success. No city in itself can furnish the outward bound cargoes or absorb the inward bound cargoes that are needed to attract ships in sufficient number to make a great port. And a port without ships is no port at all. A big, prosperous back country or hinterland, absorbing supplies from all parts of the world and supplying those things which the outside world needs, is an essential. To get these inward and outward bound cargoes from and to the port ample railway facilities are required and fair freight rates are of the greatest importance. Natural advantages in the way of location, capacity, tides and all that sort of thing are of course important, but not so important as a great many people seem to think. Certainly they count for little unless they are developed and made use of. I would put natural advantages last in the list of things necessary in the making of a great port, because disadvantages in this respect can be overcome.

Efficiency the Aim

To my mind, there should be no ambition on the part of a seaboard city to strive for great size in its port. Efficiency is the main thing and the efficiency of a port is not dependent upon great size. The port of New York, for instance, covers practically as much area as Hamburg, Rotterdam, London, Liverpool, Bremen, and Antwerp combined, but each of these ports alone has handled almost as much commerce as New York ever did. It is efficiency and the resulting economy of operation which makes a great port, and not size. Therefore, in port planning and operation it should be remembered that "every item of expense which can be scaled down represents an increment in efficiency, and each increment of efficiency that makes possible the accomplishment of results with a smaller expenditure of time and money than before is an increment in progress." One should not be niggardly in expenditures for things that make for real efficiency, but it is well to remember that every thousand dollars spent on needless things and fads means sixty dollars a year in interest charges carried in overhead thru all time.

Ideal Terminal

A well known port authority gives the following description of an ideal terminal.

"The ideal seaport, as it would be laid out and operated today, if it could be constructed new without any inherited handicaps of location or practice, would, so far as overseas carriers are concerned, consist of an extensive group of publicly owned piers, concentrated in location. Each pier would be at least 250 ft. wide, with two depressed railroad tracks down the center, and one flush track on each edge, outside the shed. There would be a railroad yard outside each pier group to which all pier tracks would run. In this yard, cars from all railroads would be held and classified for the steamer lines, both loaded cars for export and empties awaiting the loading of import material. A belt line, publicly owned, would connect with the terminal yards of all rail carriers and switch cars to and from the pier terminal yard. At a flat rate the belt line would deliver and collect export and import cars for all railroads. Each steamship line, thus cut off from all rail carriers, would have all of them at work to secure its traffic, competing by intensity of inland and overseas solicitation of routing as well as by service, car supply and prompt rail movement."

Baltimore Falls Short of Ideal

I am willing to admit that Baltimore falls short of the ideal. Our overseas piers are scattered in three dispersed groups, not co-ordinated with each other. Each pier group has its individual yard. Not only is an efficient belt line lacking, but the roads will not even interchange cars of foreign freight at their existing points of connection. The steamship line has but one rail carrier working for it.

Advantages of Ideal Port

The advantage of an ideal port lies in the fact that a shipper in any part of the country has a choice of shipments over any of the railroads serving the port at the same flat rate to the terminal, and can select that railroad which gives the best service. The advantage to the municipality would lie in the increase of the commerce which passes thru the port due to the competition, the superior service rendered and the increase in the ancillary industries which naturally follow such an increase in commerce.

Terminal Organization

Such an arrangement would naturally mean an investment of capital on the part of the city for the construction of the belt line and its yards as well as for the construction of the piers, and the revenues from such terminals should be adjusted so as not only to operate these terminals and maintain them, but possibly to amortize them, in a period of years. While it would be to the advantage of the muncipality to finance and control the operations of such terminals, the actual work of conducting the operations could most advantageously rest in the hands of a terminal organization, composed of representatives of the railroads, steamship lines and the municipality, the actual operation and management thereby being entirely independent of politics so far as the personnel of the operating forces is concerned.

Commission's Plan

In the proposed development of the Port of Baltimore, the Commission which has been appointed to plan and direct this work is a constructive and not an operating force. What changes may be made in this arrangement in the future, it is needless to discuss now. As at present organized and with its powers limited as they are now, it can do no construction until a lessee is found. After a year's study of the physical, commercial and traffic conditions of the port it is now preparing its working plan and is ready to proceed with development. The plan will be an outline of the improvements which will best serve the interests of the port and the municipality; a working scheme and a guide for each step of the performance in order that the completed whole, which may take years in the accomplishment, may be harmonious in the working of its individual parts.

The Problem

The problem involved is of a tripartite character, with its commercial, financial and engineering features intimately dependent upon each other. The commercial feature is embraced in convincing transportation, industrial and commerical interests that it will be more profitable to ship thru Baltimore than thru any other port. Our civic bodies, are intimately interested in this phase of the problem and much of the success of the development of our port will depend upon their efforts. It will be these bodies which will take up, among necessary things, the matter of governmental discrimination and favoritism.

As for the financial feature, that has been solved. The city is authorized to sell stock for the purpose of carrying on the development. But the functioning of this financial part of the problem is dependent upon the success of the commercial part. No money can be raised or expended until the commercial part has made good to the extent of finding lessees for the piers which the Commission is authorized to build.

The engineering or construction feature comes within the authority of the Commission but its functioning is dependent upon both the financial and commercial features. Therefore, since the construction part of the problem is dependent upon the financial part, and this in turn, upon the commercial part, the essence of our problem of port development under the Enabling Act is not the building of terminals, which is a simple matter, not the financing of the work, which is provided for, but the securing of lessees in advance of any work of construction.

Essentials for Success

It thus appears that progress in the development of the port of Baltimore depends primarily upon the activities of the business and commercial associations of the municipality, upon the skill and initiative which the men of Baltimore bring into the business of increasing overseas traffic thru the port. It would be useless to construct the most perfect port facilities without the hearty co-operation of these bodies and the development of the export and import business here. We have the railroads, the back country, the hinterland, and from a tremendous section we furnish the nearest and most direct outlet to the sea. We count on the co-operation and the broad vision of the officials of the railroads serving Baltimore. In co-operating with us, they help themselves. They require freight, in order to exist, and they get it thru their commercial agents. They have made our port and helped to make the city, and there is every reason why the business and commercial bodies of the municipality, which are equally great commerce-soliciting activities and thereby while helping themselves also help the city.

Unification and Co-ordination

Finally, those intrusted with the development of the port should not only control the port itself and direct its development, but should be in a position to arrange matters so that all railroads are able to furnish freight for any ship in port and to receive freight from any ship, on equal terms. And back of all this, with progress dependent upon it there must be an active, aggressive business citizenship, hustling for themselves, hustling for the city and the port, going after everything that tends to stimulate the flow of business to the port and city, and fighting to remove everything that tends to check or interfere with that flow. There must be an active municipal organism. We aim at unification and co-ordination in our mechanism. In order to get them we must have unification and co-ordination in our organism.

THE ENGINEER STUDENT AND PUBLIC SERVICE

By A. N. Johnson, Dean, Engineering College, University of Maryland

An important field which the engineer has scarcely entered, and in which he now plays but a very small part, indeed, is the direction of public affairs. The rôle that is to belong to the engineer is hardly realized, even by the profession itself, much less by the general public. But there is arising in the minds of engineers of vision a realization of the larger field of usefulness that awaits the technically trained man.

There have been few meetings of engineering societies, held in recent years, at which the question of recognition of the engineering profession by the public has not been discussed. Arguments, supported by statistical data, have been presented that demonstrate the value of the engineer's services to modern civilization, often accompanied with the complaint that the public has not been duly appreciative. In some instances, to be sure, the discussion has revolved about the rather narrow and selfish phase of the situation, that of increase compensation for the technical services of engineers. But usually a broader viewpoint has been held, with the object to secure to members of the profession a greater degree of responsibility in the direction of public affairs.

As typical of the sentiment expressed, the following extracts from a recent address before student members of the American Society of Mechanical Engineers by Dexter Kimball, are of interest. "If the engineer," he said, "has not been appreciated as much as some other classes of men, it is because his service to humanity has not been the highest"; but, be concluded, "I have every confidence the engineer will rise to this opportunity, and there are many signs that these ideals are stirring in the minds of forward-looking engineers."

The profession in England finds itself in much the same position as in America as regards its participation in public affairs. An editorial from the November, 1920, *Engineering* calls attention to the fact that England has never had an engineer as Prime Minister, nor in fact in any ministerial office, until the exigencies of the war compelled recourse to their services "to make things go." Among a number of instances mentioned, as illustrative of the utter disregard of the public for engineers' services, is one where evidence was given before a committee on London traffic and the principal witnesses were not at all the engineers in the employ of the committee, but the leaders of a political party, "who gave completely erroneous testimony on highly technical points.

In the opinion of this editorial, the serious obstacle to the engineer playing a more pronounced part in public affairs lies in the little interest taken by the public in the details of his work. But this would appear to be a secondary, rather than a primary cause, for the public takes an interest in those things about which it is informed. If the engineer does not inform the public as to his work, and does not display an interest in public affairs, it is not surprising that the public takes but little interest in the engineers' affairs.

Another writer, commenting on the part the engineers have taken in public health activities, calls attention to the opportunities for engineers in this service; that they are limited "only by what the profession chooses to impose upon itself. Except those communicable diseases transmitted by direct infection, nearly all work to suppress and eradicate disease, involves engineering problems for the sanitary engineer; but in this phase of the contact of the profession with the public, the activity of the profession has not been manifest."

All the many arguments that are to be found in the proceedings of engineering societies show conclusively, at least to the satisfaction of the engineers, that their training and attainments would secure for the public a more efficient management of many of its more important undertakings; and the engineers are probably right. But the fact still remains that the public does not intrust its affairs to engineers, even in those instances where all agree that the technical skill of the engineer must be employed. And so the engineer reports while someone else directs.

Perhaps sufficient comment has been made as to the present relation between the engineer and the public. That the engineer should have greater recognition and be shown a greater degree of confidence by the public is doubtless true. But it is idle for members to complain that the public does not render due appreciation to the ability and skill of the engineer. It remains for the engineers collectively and individually to take a more active part in public affairs in general. In this particular members of the legal and medical profession have far outstripped the engineers. If the highest recognition is to come to the engineers, they should not wait to give evidence of their interest until some technical phase of a public question arises.

If members of the engineering profession should be intrusted with greater responsibility in the management of public affairs and such has not happened, it seems obvious that the engineers themselves have not, as yet, made the right move for the desired end. That tradition is against such recognition, and that the engineer is usually handicapped by lack of intimate knowledge of the relation between political organization and management of public affairs, is to suggest that engineering schools may be not only of assistance, but have an obligation to discharge, to assist their students to gain a different viewpoint as to what their careers may be.

When the only outlook presented the student is to become a good technician, there need be little surprise felt if these men individually, or as a group, develop a field of activity that occupies in the public mind a position secondary to that of men who look forward to careers in public life, and take, and are conceded leadership in public activities.

It was with these considerations in mind that the following statement was written as it appears in the 1921-22 catalogue of the University of Maryland. Under the heading, Engineering College, it states that the courses are undergoing re-organization and that "the general purpose is to broaden the courses of instruction the better to prepare young men to enter the public service. The large public-works program contemplated in practically every state in the union makes urgent the demand for engineers trained for such work. The public service demands the electrical and mechanical, as well as the civil engineer. Maryland needs such men to carry on her great highway and large public undertakings contemplated in various cities and counties. Such training seems pre-eminently a function of the State's university.

"It is not the intention that the subject matter of the courses shall be essentially different from that usually given, but that the viewpoint of the student and the application of the principles will be that of public service. In order to give the time necessary both to the technical subjects and to those of a more general character, a careful revision of all courses of study is being made so that the utmost time available in each term may be used to the best advantage."

Why not inculcate in the mind of the young engineer that he is as well fitted "to rise in meeting" and discuss the public questions of his community, as, say, his brother from the law school? Why not give him the inspiration to take part in public affairs? Why not dispel whatever remains of the tradition that the technically trained man should shun politics? All of these things can be done by our engineering schools. Should they do them?

It is the writer's conviction that it must be done if the engineer of tomorrow is to discharge in a larger and fuller measure his obligation, not alone to himself and his profession, but to his community. We shall not, much longer, be able to carry on our public and quasi-public affairs as in the past. The call is to come to the trained man, to the engineer, to take charge. In the new fields that await him, he will have far greater responsibilities. Let us help him be prepared.

DISCUSSION

MR. GRINNALDS: I want to endorse what Mr. Johnson has said about the engineer getting into the broader municipal work. There is an opportunity for the engineer if he will grasp what we term nowadays "city planning." I have been trying for the last year to get some recognition for that branch of engineering or general work in the University of Virginia. I am urging the student to study city planning, because it is not a specialized subject in that it may be railroad engineering or street paving or any one of the branches of technical work, but it embraces all of them. It is the means by which the man may become interested in every phase of municipal improvement. It includes zoning, of course. It is not only an engineering subject, but it is a legal subject, it is an economic subject, it is psychological, and it has a great deal to do with the health of the city. It is one of the broadest subjects that a man could study. He must needs learn something of every one of these individual branches that I have mentioned to pursue it successfully. So I would urge colleges and universities to try to train the men to think broadly along the lines suggested by city planning. Lawyers are interested in it; architects and landscape architects; and I believe I am right when I say that most of the work in city planning has been done today, up to this time, by architects and landscape architects; but it seems to me the engineer is the man, the man with the broad training, that should be the city planner.

MR. HATTON: I just want to give one thought to the subject of engineering training, and it is something that I have been trying to promulgate through some of the universities in the West in my lectures that I give there. It is not a question of engineering and politics, especially of the engineer being interested in politics, because he will get interested in politics if he is able to express himself, but every one that has been at these engineering conventions from time to time for the last fifteen or twenty years realizes that the engineer is practically the poorest educated man, to express himself before the public. The lawyers all get into politics because they are blatherskites, and if the engineers would do a little blatherskiting, and know how to do it, we'd all get into prominence just as well as the lawyers do, and we would lead the lawyers because we know more about what we are talking about, if we can only express ourselves. It has been my earnest desire to spread among the universities with which I have come in contact the necessity for teaching the students the art of publicly expressing themselves on all occasions and not to stay in the background and listen to a man, a lawyer, talk about a public thing of which he knows very little. That is the thing for the universities to do, to teach a man good English first and then how to express himself before the public on every occasion, not only before the public but before the Board of Directors, Councillors or Commissioners, and then he is going to be the leader of this country instead of the lawyer.

REPORT OF SUB-COMMITTEE ON SNOW REMOVAL

Thomas F. Sullivan, Chairman, Boston, Mass.

The excessive snow fall of the Winter of 1919 and 1920, where storm succeeded storm at such a rapid rate that the existing organizations were entirely ineffective, was responsible for giving the snow-removal problem an importance never anticipated heretofore. With business in our large municipalities almost at a stand still, which involved a loss of millions of dollars, vehicles of all kinds buried in the main highways, with thousands of miles of traction lines abandoned, the safety of the community jeopardized by the inability of fire apparatus to function and the health of the public endangered by the failure to collect and dispose of putrescible wastes, it was to be expected that this situation would arouse public sentiment to demand an organization qualified to prevent a recurrence.

The officials in the Northern section of the country who have been handling snow for many years had brought home to them very forcibly that instead of waiting for the storms to subside before commencing to remove the accumulation, as had been the custom, it was absolutely necessary to go out and fight the storm the moment it commenced, and to clean up that accumulation in anticipation of a second storm. It was further demonstrated that every conceivable mechanical device should be brought into action in the early stages of the fight to keep the main lines open. This new code requires a comprehensive snow-handling organization. It is not the intention in this brief synopsis to attempt to suggest any rules but to call to the attention of those members of this Association who are affected by this problem, some of the methods that might be used to advantage.

There can be but one commander in a snow storm, and the executive officer in charge of this work must have absolute authority.

After the general policy of a community relative to the amount of money available for this purpose or the sections to be cleaned up have been determined, no further interference with the executive in charge should be allowed. After the snow has been removed, there is ample time to discuss the shortcomings of what has taken place and much better results will be secured if this policy is strictly adhered to, for snow handling is a disagreeable problem that tries the temper and patience of the most conservative official.

One of the first and most important duties of the official in charge is the selection of his supervising force. Men of intuition, capable of acting alone and prompt to act as well as think, are necessary, for it frequently happens that when the situation is most acute, conference with higher authority is impossible, thru failure of the quicker methods of communication. It is extremely important however, that regular communication, if only by messenger, be maintained at all times between the various elements of the organization and the executive in charge, for like a General in the field, he alone with his immediate staff is in a position to render assistance at critical periods. The supervisors must be intensely loyal to their chief and physically fit to withstand the inclement weather, long hours, and irregular meals that an assignment of this kind requires, and it is much better to eliminate a physically unfit supervisor from the proposed organization than to relieve him during the battle.

With the skeleton of the district organization completed, the next important move is the assignment of equipment. This apparatus is thoroly gone over and checked up in the late summer or early fall and should be transferred to its operating station before any possibility of a storm. Familiarity on the part of the operator with the type of apparatus is, of course, essential, and substitute operators should be provided for in advance. An alarm list for notifying all employees to report should be established in each sub-division, and it is a good policy to check the effectiveness of this alarm list by testing it out before the winter.

Charts should be prepared in advance showing routes to be plowed, the type of apparatus to be used at different stages of the storm, with the name of each operator and his substitutes, the location of dumping places, the number of men in each crew, the order in which certain areas should be given attention, and any other local details which might be necessary.

It is a good policy to have a conference or "snow" meeting in the late fall at which all of the supervisors, including even sub-foremen, should be present, and where the general subject is thoroly gone over, and reports are received for checking up details of the plan. This meeting will give the executive an opportunity to discover if essential details are lacking.

The ordinances in many communities vary in their legal requirements for assistance from traction companies and other public-service corporations. It is to the advantage of the entire community, where cooperation is maintained between the officials of the municipality and the traction companies, and conversely without this cooperation there is an appreciable waste of money on both sides. Where the local regulations provide for the removal of snow from roofs and sidewalks by owners or occupants, the police department can greatly assist in requiring prompt compliance, thereby avoiding a second clean up on the same street.

The plowing of gutters and freeing of catch basins is an essential matter and permanent markings should be provided for to designate the location of these basins, so that they may be quickly discovered after a snow-fall. Wherever the snow is plowed towards the gutter, particularly on streets containing railway tracks, the supervisor should be quick to take advantage of a thaw or rain by promptly back-leveling these piles onto the tracks so that the snow can be cut up by cars and trucks.

Motor trucks with mold boards, and tractors with road machines that are used in construction and maintenance work in the summer, are now being used to advantage in opening up thorofares. The rotary broom attached to a heavy motor truck, has been found exceptionally effective on boulevards and highways in the outlying sections of New England where the piles do not have to be carted away. One of the principal difficulties in the removal of snow has been the inability to get hand-shovellers to continue at work after midnight. The motor-driven snow loader mounted on a tractor, which requires only one or two trimmers to feed it, is the solution of this problem. Sewering snow is a prompt method of disposal in the larger cities, if sufficient flow is obtainable, and a tremendous saving in cost can be made thru judicious use of sewers.

I have simply sketched the "high-spots" which are applicable to the larger cities in the matter of handling snow. On account of its magnitude and importance to the community, combatting and removing snow has advanced from the old methods of men, horses and shovels, to a highly trained engineering achievement and it is our duty to be prepared to meet these new obligations successfully.

REPORT OF COMMITTEE ON STREET LIGHTING

This report is supplementary to previous reports. It is the aim of the Committee to bring to the attention of the Society any improvements in the art of street illumination or any tendency to changes in street lighting installations and equipment.

Gas-filled lamps are replacing the arc lamp and very few installations are made with other than that of the gas-filled incandescent lamp. These units consist of 1000 c. p., 600 c. p. 250 c.p., 100 c.p., and 80 c.p. Even in intensified illumination of many thorofares the gas-filled lamp of the large unit seems to be in favor, for the reason that they are easy to take care of, give a constant and steady light and can be adapted to almost any kind of an installation.

More and more ornamental street light installations are being considered and installed. During the war period there was a lull in additions to street lighting systems but with the reduction of prices of materials municipalities are again considering the installation of ornamental street lighting systems. The one-light standard on residential streets is preferred and the choice of glassware tends to remain with those who pay the bill. However, there is an effort being made to get away from the plain ball glassware to the lantern type heads which offer an improvement not only as to looks but also as to economy in the replacement of broken glassware. The ball globes have increased in price until they are almost prohibitive while the price of replacement of the lantern type is only nominal. They are inexpensive and have a very attractive appearance where properly designed.

There is a globeless street lighting unit offered on the market now, recent installation having been made at Rochester, N. Y. This unit eliminates the initial expense of the glass ball globes and the breakage in the handling and operating; the lamp support being decorative and giving a neat appearance. The unit does away with the absorption of the diffusing globe, giving 25 to 40% more light.

In the past many cast-iron posts have been used, but the cement post has come into favor in the Middle West and especially on the Pacific Coast, since certain manufacturers of cement posts have learned how to make a post that will not disintegrate or crack and since it is possible to design and finish them in a most artistic way. The adoption of the concrete post eliminates the necessity of continual painting and thereby saves in the cost of maintenance. As to the height of the post, this varies. The spacing necessarily has to be arranged in accordance with the candle power and the height of the lighting unit. 80-and 100-c.p. lamp units are spaced usually 75 feet apart either staggered or opposite. Other units range around 100 and 110 feet apart, or the rule of seven or eight times the height can be applied for proper spacing. With the large units the height increases, especially with the maximum lighting units, where the height goes to 25 or 35 feet in some instances.

The cost of installation of ornamental lighting systems is still high. Whereas before the war it cost approximately 80c per property front foot for one-light installations, 80-c.p. units, it now costs $1.30 per property front foot and other installations in the same proportion. The usual method of payment for installing ornamental street lighting systems is that the abutting property pays for the total installation and also pays for the increase in illumination over that ordinarily furnished by the city on other streets where the ornamental system is not in use. Where the city is entirely lighted by the ornamental system the city at large pays for the total illumination and in some places the city at large pays for the illumination of all street lighting, whether ornamental or not.

The wiring for all ornamental lighting systems is, as a matter of course, underground or should be. The wire installation should always be lead covered. Experience has taught us that anything else is very costly to maintain. The lead cable can be pulled in conduit or it can be laid in the parking with 2-in plank over the top for protection. Also it can consist of lead-armored cable. The method of control is constant current regulators with film cut-out socket or the same with compensator at the base of the post or the constant potential transformer with reactance transformer at the base of the post.

The method of charging for ornamental street lighting is usually on the basis of kilowatt-hours rather than the lamp unit. Overhead series lighting is still charged for at a fixed price, for the various size units per annum, whether operated on moonlight or all-night schedule. Relative to the moonlight schedule, the time has passed for continuing the moonlight schedule in a city of any size. With the use of the automobile it is highly desirable to illuminate the streets every night, at least until midnight. It makes it safer for driving. The illumination counteracts the glare from automobile headlights, enabling the driver to see beyond the on-coming car, thereby increasing the safety of night driving.

Where the city installs its street-lighting system it should be taken into consideration when the contract is being made for electrical energy for supplying it, the city naturally being entitled to credit for its street-lighting system as compared to the price that was formerly paid when the company made the investment for the system.

The cost of street illumination varies considerably. In some cases ornamental lighting is furnished at 3¼c to 4c per kw.-hr., whereas the overhead lighting ranges from $15.00 and over per 100-c.p. unit to $50.00 and over for 600-c.p. units. There have been many changes in street-lighting costs during the war and increases have been granted in some instances, except where contracts were in force and where the city is not under the regulation of commissions. For the 600-c.p. lamp the common rate is around $60 to $65 a year.

It has been learned from experience that ornamental street lighting, in addition to adding to the charm of a city or the section of the city in which it is installed, adds considerably to the property value. This is not only true of the residential districts but is also true of the business districts. There is no getting away from the fact that the better illuminated business streets attract a greater and better class of trade. This has been the experience of merchants who have tried it

It is a long way from the tin lantern that hung at the doorway for lighting the footsteps of the passer-by to the present modern street lighting systems. Municipalities are in competition in the race of civilization and whether they want to or not must adopt up-to-date street lighting systems or be put in a class with the ultra-conservative.

Respectfully submitted,
C. W. KOINER, *Chairman*
WM. F. SCHWARTZ
T. J. WASSER

THE MARYLAND CASUALTY COMPANY'S BUILDINGS

By Otto G. Simonson, Architect, Baltimore, Md.

While you are assembled here in Baltimore to discuss problems of Municipal Engineering of public improvements and better construction of public works, such as sewers, water, parks, streets, city planning, zoning, public and private utilities, housing, etc., it will be interesting to make you acquainted with the just completed development of the Maryland Casualty Company, this being the first and one of the largest companies in the United States which moved its home office buildings, wherein over one thousand employees are employed, from the business center to the residential suburban section of Baltimore.

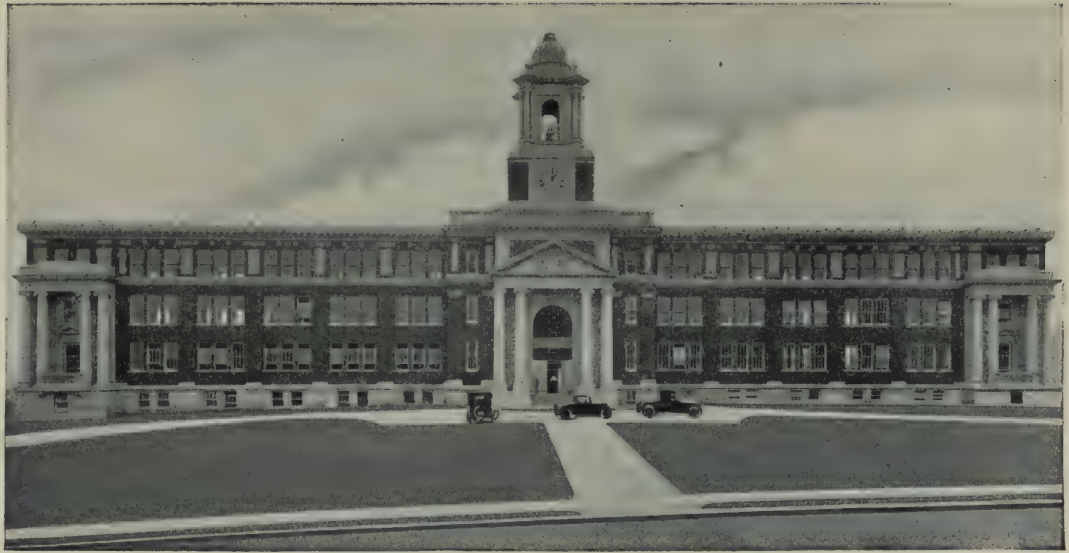
Description of the Development

The late President John T. Stone, in August 1919, announced the purchase by the Maryland Casualty Company of about twenty-five acres of land, located on one of the highest points and in one of the most desirable sections of the northern part of Baltimore, for the purpose of removing the head offices of the company to that location, necessitated by the overcrowded condition of the present home office building, the continued growth of the business and the undesirability of enlarging the existing quarters, and to prevent the recurrence, from time to time, of the demand for additional space to meet the needs of the business of the rapidly growing company. In addition, the company desired to minister to the welfare, comfort and convenience of its employees consistent with reasonable business considerations.

The demands of the company, the size of the grounds and the location in the residential section of Baltimore made it advisable to have separate buildings, which have been grouped in a manner suitable to the topography of the land. This takes into consideration the most important approach to the site and allows the best communication between the buildings.

The administration building occupies the center of the group with the approach from Fortieth street at a distance of 140 feet. The club house has been located to the east on the lower ground elevation, while the industrial group has been placed to the west towards Elm avenue. The latter consists of a garage, which faces Fortieth street, a printing plant and a power house, the last two in the rear of the garage in the order named.

Terraces, flower beds, trees, shrubberies, pools and walks will form a park between the administration building and club house. There will be lawns and a service driveway between the administration building and the industrial group. South of the



1. *Front View—Administration Building*

club house are located tennis courts and a baseball diamond. The grounds, walks and driveways are illuminated by electric light standards.

Architecture and Construction

The style of the architecture is Modern Italian. The buildings are fireproof in construction, the foundations are concrete, the bearing walls brick, the floor and roof construction reinforced concrete of the flat slab system. The exterior is of stone, red face brick and ornamental terra cotta.

Administration Building

The administration building, with its tower containing a clock and Westminster chimes, dominates the group. The structure is 320 feet long and 260 feet deep and consists of three buildings combined into one, forming the letter H. The two long parallel wings are each 320 feet long and 60 feet wide. There is a basement under the entire building, which is three stories high. The basement is well above the ground and consequently well lighted and ventilated. The general decorative scheme is light buff walls and white woodwork.

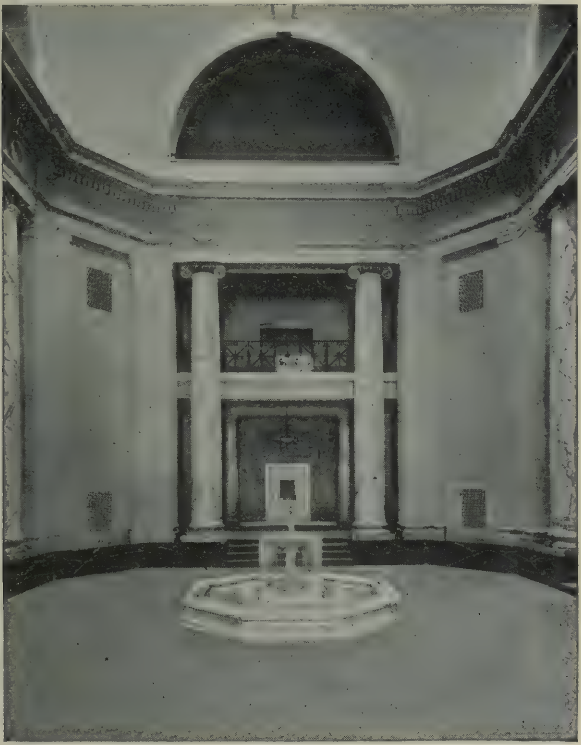
2. *Front, Rear and Central Wings—Administration Building*

The main entrance with the Maryland shield carved in stone over it, leads into a monumental rotunda, which is a focal point from which the other portions of the building are reached.

The floor of the rotunda is several steps lower than the main first floor. This difference in height acts as a base for the octagonal shaped structure, from the four smaller sides of which a dome rises on pendentives at the third floor line and terminates in an art glass skylight, also domical in shape. The four larger sides of the octagon, which are on the two main axes of the building, are made up of large marble Ionic columns, between the Caenstone pilasters supporting the cornice and arches above. Between the arches are the pendentives on the four smaller sides. The entire rotunda, except the marble base, pedestal and the marble columns and bases and bronze caps, is of Caen-stone.

Around the rotunda on each floor runs a corridor which connects the three main divisions of the building.

On entering the building a marble stairway leads right and left to the basement, where locker and toilet rooms for the employees are located. This stairway continues right and left of the entrance to the two upper floors. In the center of the rotunda floor is an octagonal shaped marble fountain. The marble base of the rotunda is Verde Antique. The column and pilaster bases as well as the columns are of American Pavonazza. The stair risers and treads are of Tennessee marble.



3. *Rotunda*

Leading from the rotunda is the entrance to the presidents suite and treasurer's department, both located in the left wing. The President's suite, on the south side, consists of an entrance hall, waiting room, offices for the President, assistant to the president, private secretary, publicity department, directors' and executive committee rooms.

The president's office is finished in walnut panelled walls and decorative plastered ceiling.

4. *Directors' Room—President's Office in the Rear*

5. *Secretary's Department*

The board room has mahogany panelled walls and plaster panelled ceiling.

The treasurer's department, which faces the north side of the left wing, is approached thru a public entrance lobby separated from the working space of the tellers and clerks by a bank screen. Vaults for the safe keeping of money and securities and the private office of the treasurer complete this department.

The right front wing is devoted solely to the use of the secretary and his department.

6. *Court, Front and Central Wings and Tower, Administration Building*

The central wing is divided into two parts by a corridor leading from the rotunda to the rear wing. On the east side of the corridor is located the legal department with a general office, private offices, consultation room and law library. On the west side is placed the infirmary, consisting of the nurses' office, with ante room, the doctor's office, fully equipped, and separate wards for men and women, also a rest room for the women.

The entire rear wing of the first floor is occupied by the auditing division and the bureau of payroll audits.

The office of the first vice-president, with ante room and secretary's office, is located on the south side of the left front wing adjoining the rotunda. The balance of the left wing is occupied by the liability and compensation underwriting departments.

The engineering and rating bureau and the mail and manual bureau are assigned to the right front wing.

The plate glass and burglary departments are located in the north half of the central wing while the current files of the liability and compensation underwriting department occupy the south half.

The statistical division occupies the entire rear wing. .

The office of the third vice-president, with ante room and secretary's office, is located to the south of the left wing adjoining the rotunda. The balance of this wing is divided by a corridor. Here are placed the contract and fidelity sections and agency division.

The judicial and public official sections, salvage bureau and bonding claim division are located in the right front wing. The north half of the central wing is used for the current files of the bonding department while the south half of this wing contains the files of the casualty claim divisions.

7. Interior View Showing Entire Floor in Rear Unit

The liability and workmen's compensation claim division and the boiler and inspection departments occupy the rear wing.

The fourth vice-president's offices, the accident and health department and the Maryland Assurance Corporation will occupy the rear wing of the ground floor.

The entire central wing contains the locker and toilet rooms for men and women. These rooms are accessible from both stairways located at each end of the wing. Each employee will be furnished with an individual, well ventilated locker.

The front wing of the basement is devoted to the storage of files, to carpenter and paint shops, store rooms for supplies and the telephone exchange and telegraph station.

An automatic inter-communicating telephone system with one hundred stations besides the C & P telephone service has been installed.

The building is heated by direct indirect radiation with low pressure or exhaust steam of the vacuum system and lighted by electricity on the three-wire system to avoid flicker. The steam and electricity are supplied from the power house.

A fire-hose standpipe system, two electric elevators and sterilized and cooled drinking water fountains add to the safety and comfort of the occupants of the building.

Club House

The club house is 262 feet long and 82 feet wide. It consists of a basement and two stories. The building has two entrances, one on the east side towards Cedar avenue, the other on the west towards the private interior roadway separating the club house from the administration building. The entrance and hall divide the building into two sections.

8. *Club House*

Recreation rooms for women are provided in the north section of the first floor. A large central unobstructed area affords space for dancing or other social gatherings. Homelike reading and lounging rooms flank both sides. Cloak and toilet rooms are also provided. The second floor of this section contains lounging, smoking and library rooms, cloak and toilet rooms for men; also a private dining room with serving rooms for the officers of the company.

Four rooms each with private bath for the use of visiting agents occupy this section. The club rooms are painted in tones to match the draperies and furniture, especially selected to produce a cheerful and homelike appearance.

The auditorium occupies the south section of the club house with a seating capacity of 1500 on the main floor and in the balcony. It is designed to give the best sight lines and perfect acoustics. The distance from the curtain line of the stage to the rear line of seats is only 85 feet, while the width of the auditorium is 78 feet. This arrangement brings the audience close to the stage. The floor is properly pitched and bowled. Spacious aisles and adequate exits are provided. The proscenium

9. *Aeroplane View—Looking North*

arch, balcony front, walls and ceilings are finished in ornamental plaster painted in cream yellow tints. The draperies are of mulberry velvet. The chairs are upholstered and covered with leather in color to harmonize.

A fully equipped stage, including exterior and interior scenery and olio curtain, makes dramatic presentations possible. A large Austin concert and echo organ, one of the finest in the city, and a moving picture operating room add to the completeness of the arrangements. A wide stairway in the central hall gives access both to the auditorium balcony and to the men's club rooms upstairs, and to the basement entrance to cafeteria.

10. *Garage and Laundry*

In this lobby a counter and wall case has been provided for the sale of candy, cigars, cigarettes, books, papers, magazines, notions, etc.

In the north end of the basement is located a cafeteria for the employees. It is equipped in the most modern and approved style. This room is finished in cream tile wainscot with the walls and ceilings in cream color with green tints; the floor is of terrazzo.

There are two white Carrara glass service counters with nickel silver trimmings each 52 feet long equipped with display shelves, salad pans, steam tables and dish heaters, ice cream serving cabinet, coffee, hot water, tea and cream urns. The cafeteria is furnished with 125 mahogany finished tables with white glass tops to match service counters and 500 mahogany finished bent-wood chairs, thus enabling 500 persons to lunch at one time. The kitchen and bakery is fully equipped with a four-section hotel range, gas broiler and toaster, steamer, kettles, meat chopper, paring machine, pastry furnace and kettle, cake mixer, bake oven, work tables, sinks, butcher's block, pan racks, bread rack, pantry counter, oyster bar, etc. Large refrigerators for meat, vegetables, milk, fish, pastry, etc. are provided. A refrigerating plant furnishes the refrigeration for the large storage refrigerators and also manufactures block ice and cools the sterilized drinking water in the club house.

A Champion dishwashing machine with a capacity of 12,000 pieces an hour and an incinerator to burn the garbage complete the equipment.

Separate dining room locker and toilet rooms for the help are also provided for.

An automatic electric dumbwaiter connects the kitchen serving room with the serving rooms on the first and second floors. The latter are provided with refrigerators, sinks, steam tables, etc.

11. *Interior View—Printing Plant*

A well ventilated underground reinforced concrete tunnel 9 feet wide and 9 feet high, 240 feet long connects the administration building with the auditorium of the cafeteria, thus protecting the employees in inclement weather.

The Garage

The garage, the front building of the industrial group, located to the west of the administration building, altho designed as an industrial structure, harmonizes, as do the others of the industrial group, with the general design of the other buildings. It is 120 feet long and 55 feet wide. There are two floors for the storage of cars. Due to the contour of the land at this point and the grade lines of Elm avenue, approach to the lower level is from Elm avenue, while the upper level is entered from the front driveway. Space for the storage of forty cars is available. It contains an office for the foreman in charge of the garage, storage space for accessories, bench for repair work, rest and locker room for chauffeurs, a toilet and a gasoline tank and pump outfit.

A laundry is located in the second story over the front part of the garage, above the upper level, is fully equipped with a universal press, extractor, washers, soap tank, tubs, mangle, dryer, starch cooker, bins, ironing board and tables. This will take care of the linen used in the dining and wash rooms. It is provided with a room to store and repair linen; it is also for the use of the person in charge. The laundry entrance is from the upper service. A lift carries the laundry work from the entrance to the laundry floor.

This building is fireproof in construction, and the mechanical equipment is similar to that of the other buildings.

12. *Printing Plant and Supply Division*

Printing Plant

Back of the garage and laundry is located the printing plant. It follows the design of the garage to utilize the irregular grade lines of the ground and Elm avenue. The building is 120 feet long and 60 feet wide and consists of two stories and a basement. The entire second floor is given over to the printers and compositors. It is excellently lighted from the four sides and thru ventilating skylights. An office for the superintendent of printing and his office force is placed on this floor.

The plant equipment consists of two cylinder presses, four automatic feed Kelly presses, eight job presses (one automatically fed) two B. & C. cutting machines, one Harris envelope press, one Robinson rotary cutting machine, two Boston wire stitchers, one Tatum punching machine. The composing room is equipped with a new model Intertype composing machine and the latest style Miller saw trimmer.

The supply division is located on the first floor and this floor and the basement are used for the storage of supplies. A covered loading platform opens on the interior service roadway. Adjacent to the platform is a centrally located freight elevator which permits the handling of supplies in large packages between the loading platform and all floors. The employees' entrance is near the northeast corner of the building. Locker and toilet rooms for men and women are placed conveniently near this entrance. The heating, lighting and other mechanical arrangements are similar to those in the other buildings.

Power House

The Power House brings up the rear of the industrial group. It is divided into two parts, the boiler house to the west, and the engine room to the east. The combined dimensions are 102 feet long and 52 feet wide. The floor of the engine room is 8 feet higher than that in the boiler house. The grade elevations of Elm avenue and the grounds required a similar treatment in this building to that given in the garage and printing plant.

13. *Power House*

A coal vault 32 feet by 58 feet is built in this structure so that fuel is delivered from the service roadway without any mechanical handling. Erie City Iron Works water-tube boilers are placed facing the coal vault to require the least labor for firing. Taylor stokers are used. Ashes are removed by an American patented steam-jet ash conveyor. A brick smoke stack stands 125 feet high and 6 feet in diameter (inside) at the top.

Two 253-h.p. water-tube boilers manufactured by the Erie City Iron Works, two Lentz engines and two Crocker-Wheeler generators—one 150-k.w. and one 100-k.w., furnish the power, heat and electricity for the entire development. A refrigerating plant cools the drinking water and furnishes refrigeration for kitchen use. A watchman's time detector service and fire alarm system are installed thruout.

Underground concrete tunnels, which carry the steam, water and gas pipes, electric conduits and cables, connect the Power House with all buildings. The tunnels are built to permit workmen to work thru for inspection and repairs.

MEETING THE SCHOOL PROBLEMS

By J. F. Crowther, Inspector of Buildings, Baltimore, Md.

During the last few years probably no one subject has been given such countrywide attention as the problem of adequate and safe school houses and provision of the proper facilities and equipment in the same. The utmost attention is being directed to designing and erecting these buildings, as indeed it should; to adequate seating capacity, proper ventilation, lighting both artificial and natural, adequate heating equipment, the elimination as far as possible of fire risks, etc.; and also to the maintenance of this equipment after installation.

These problems have been particularly acute in the larger cities, where the tremendous influx due to the war and the city's natural growth, coincident with the cessation of building during the war period, have in some cases almost flooded the established school facilities.

The proper extension of school buildings and equipment has in general been impaired by reason of entirely inadequate appropriations for new buildings or for the proper maintenance and modernizing of the old ones. Work of this character has further been practically at a standstill during the more recent years due to the difficulty of obtaining labor and materials during the war and the almost prohibitive cost of the same immediately thereafter. It has, therefore, not been until very recently that the school housing situation has been met in anything like a satisfactory manner.

In attempting to meet the above combination of circumstances several of the cities, including New York, were forced to resort to the half-time school system. Under this scheme, one portion of the scholars was required to attend school from say eight thirty in the morning to probably half past twelve, with a second portion attending from half past one to five thirty. This system, to say the least, was most unsatisfactory, and I am glad to say, in Baltimore at least, will be unnecessary this season, due to the fact that we have made considerable extensions during the past year, building new schools and remodelling present ones to place the same at least in fair condition.

Another cause of poor facilities in equipment and building proper, has been that no cooperation formerly existed between the various municipal departments concerned in school administration, and no general outline or schedule was formulated of requirements to be met. Thus when an architect was selected by the municipality to prepare plans for a given sized building, he followed his own judgment almost entirely. He had a certain sum available to expend more or less according to his idea of school design, and did so. In some cases he knew or cared little about the equipment and general facilities of the building, so long as the structure proper and appearance were correct; in which case too much of the money was spent for excessive ornamentation, etc. Naturally his building was a success only from the standpoint of the appearance, and the city and pupils suffered.

The next school building constructed would usually be designed by a different architect, as most cities divide their work among the local professional talent. Probably his ideas ran to excellent equipment and furnishings, even if the building appearance suffered. With the same gross total to expend on a building of the same size as that designed by the first architect, naturally the ornamentation of the second building would have to be curtailed to some extent. While the latter was the better of the two school buildings, the average outside viewpoint was that the second designer had not made good and this architect would, therefore, in all probability, design no more buildings. A system of this sort undoubtedly resulted in building primarily for appear ance and many cities have today monuments of this method of design.

Cities in general are now adopting an entirely different method of attacking the various school problems, and are employing the most expert advisers they can obtain. These men are familiar with each phase of the school situation and usually are totally disinterested in either expensive buildings or too elaborate equipment, but are endeavoring to obtain buildings containing the highest percentage of facilities for efficient and safe school housing. These experts, together with representatives of the school board, the municipal engineers, etc., of the various departments and the professional architects and engineers of the city, are brought together as a committee, to formulate a series of requirements which are to be met in building new schools or remodelling older buildings.

These standards once set are thereafter adhered to for each construction project until altered by action of the committee. In this way, while the originality of design is not removed from the various architects and engineers upon the buildings, each building is assured of being equipped with the essentials desired.

The city of Baltimore for instance, during the past year voted approximately $6,000,000 for school improvements and every dollar of this amount is being expended in accordance with recommendation of committees similar to those above outlined. The results of the preparation of plans along these lines has further resulted in closer bidding on similar buildings and the improvement of the character of equipment submitted by various bidders.

In addition to forming of the committees above mentioned, it would probably be advantageous for cities to send their engineers thru the surrounding territory to inspect the improvement made and plans for those contemplated, so that items worthy of consideration could be embodied in their school-building code. Many technical papers are also published giving items and requirements well worth consideration and these should all be discussed in the fullest detail by the committee.

The following features are some of those desirable for new buildings and should be embodied where possible in school construction codes:

Proper location with respect to population or center of districts, freedom from noises, polluted air, railway crossings, factories, swamps, etc.

Provision of an adequately drained playground adjacent to school and containing not less than 80 sq. ft. per pupil.

The placement and design of buildings to be such that the major portion of the light is from the south-east and east. Design of building should further lend itself to further additions without impairing the lighting of original rooms, and open types such as L, T, E, U, H, open square, etc. are most desirable.

Buildings should if possible be fire proof construction thruout and should not be over three stories high, exclusive of apparatus cellar. Lowest story used for instruction should if possible, not be below ground. Outside walls to be of brick, concrete, terra cotta, or similar material, with partitions of gypsum block, hollow tile, etc. All outside walls should have furring in addition to plastering.

Main entrance should be provided at center of building with secondary entrances at ends of building and near stairs. All doors to entrances should swing out and be provided with panic bolts

Stairs should be fire proof with non-slip surfaces, and not less than 4 feet wide. Treads to be approximately 12 inches with 6 inch risers. Winding steps should not be used, but stairs should have full-width landings. Stairs, further, should be sufficient in number to empty building in three minutes when figured on a basis of 120 pupils in line two abreast, passing a given point in one minute. Allowance should also be made for the fact that one stair may be blocked by fire. Stairs should lead directly to exits and should be well lighted, naturally and artifically.

Corridors should provide ready access to stairs from all class rooms, and should be overlaid with battleship linoleum or similar material. Corridors should have natural and artificial lighting and should be free from projecting furniture where likely to interrupt passages to stairs.

All heating and ventilating departments should be in separate fireproof compartments and should have outside entrance.

Ample storage space should be provided for janitor equipment, school desks, etc.

Class rooms should allow at least fifteen square feet and 180 cubic feet per pupil, with a glass area of from twenty to twenty-five percent of the floor area. Each class room should have coat room, accessible only from class room and therefore under teacher's supervision.

A play room should be provided in all elementary schools.

An auditorium or assembly room should be provided in all schools. This can also be used for a gymnasium, etc. where economy indicates. Same should have a stage and should preferably have facilities for moving-picture machines, etc. Auditorium should have area of approximately seven square feet per pupil and dressing rooms for each sex.

If possible every school should be equipped with a complete library.

All schools should be equipped with a lunch room of size to seat one-half the school capacity and should have a drinking fountain, small kitchen, etc., for light cooking, etc.

The school should also include a principal's office, teachers' room for men and women and a nurse's room. The modern school also dictates a physician's and dentist's office where feasible.

All class and similar instruction rooms should have adequate means of heating to 70 degrees in any weather obtained under local conditions, and, in addition, should be provided with fresh-air supply and vitiated-air removal system. System should be designed on the basis of thirty cubic feet of air per minute per pupil to each room. Fresh air system should further have a fan or fans to insure positive delivery irrespective of weather and wind conditions. If possible, means should be provided for adequately cleaning the air delivered to the building and the maintaining of the proper humidity of same. If the appropriation is sufficient to permit, considerable saving in coal, and better operation will be obtained by applying a high-grade temperature-control system to the heating apparatus of the building.

The air-supply system should also be equipped with temperature-regulator system to insure the most satisfactory operation.

For assembly rooms, and other rooms not in constant use, the fresh-air supply may be dropped to ten or fifteen cubic feet per person.

Boilers should be of ample size to maintain rating for approximately six hours without replenishing coal and a sufficient number of boilers installed to allow one spare for emergency. Attention should also be given to the size of the grates in the boilers selected. Grates should be short in depth and as wide as possible. Depth of grates should not be over 7 ft. 6 in. for effective handling. Boilers should be of smokeless type.

Exhaust system should have pneumatic dampers to close same off after school hours and prevent as far as possible the removal of heat from the building, and consequent usage of coal the next morning.

The heating system proper should be of the so-called vapor type with thermostatic traps on the returns.

In connection with the air supply to the building there is another item which is receiving considerable attention at present and particularly in St. Louis is being tried out with apparently good results. This is the subject of air purification by electrical discharges, using properly designed apparatus to manufacture ozone. The air supply system in most buildings takes air from the outside at say an average temperature of 20 degrees Fahrenheit, heating and delivering same to the various rooms at about 75 degrees. After this air is vitiated in the room, it is exhausted to atmosphere and thus the heat loss and coal usage is large. By the installation of the proper ozone apparatus and a suitable air washer it is claimed that the vitiated air instead of being exhausted thru roof can be returned to the central fan, ozonated, washed and re-delivered to the rooms. This air would return to the fan at probably 65 degrees Fahrenheit, in most cases, and it would, therefore, only need to be heated 10 degrees Fahrenheit before delivering to the rooms, instead of 55 degrees Fahrenheit as above. A system designed as above should save approximately 80% of the coal required for ventilation, and this item is well worth consideration, particularly as there are a number of schools in the west so equipped.

All coat rooms should be provided with adequate ventilation to change the air at least four times per hour. Where class rooms adjoin the respective coat rooms, the same can be exhausted thru the coat rooms, thus eliminating the necessity of separate heating and ventilating apparatus for these rooms.

All locker and toilet rooms should also be ventilated, lockers at least four times per hour and toilets six times per hour. Toilets should have their own fan and duct system independent of the main system.

Pyrene or similar extinguishers should be provided thruout all sections of each floor and an adequate number of hose standpipes provided for the utmost protection from fire. The building should also have a system of fire alarm gongs and stations at readily accessible locations.

All buildings should be provided with an adequate clock and program-bell system and telephone system between class rooms, a vacuum cleaning system of stationary piped type.

Each class room should have sufficient number of electric outlets with suitable fixtures and lamps to give a uniform intensity of not less than seven foot-candles. All corridors, stairways, etc., and other portions of building to be lighted in the usual manner. Red exit lights are also to be provided where required at stairs, etc.

Each class room should be provided with modern and effective lighting fixtures. In this connection the city of Baltimore has had a number of types of fixtures installed in sample rooms, and intensive tests are being made of the same to determine the most satisfactory units for the purpose.

In these tests, the points are being noted, primarily for elimination of eye strain and the production of uniform high-intensity illumination, and second, the comparative cost of the units. This item of cost, while naturally of importance, shoudl not be the deciding factor in favor of a unit which will produce eye strain or nonuniform illumination. Care should also be given that the the type of fixture selected be one permitting infrequent cleaning without marked depreciation in lighting value. The cleaning of fixtures should further be so simple an operation as to eliminate breakage of glassware.

Automatic bubbling cups should be provided on each floor of the building and in play grounds, etc. at accessible locations, but should not be in toilets.

Sinks should be provided on each floor for janitor, and additional sinks in manual training, domestic science and similar rooms.

Wash bowls should be provided in toilets in ratio of approximately 1 to 50 pupils, and should have sanitary soap and towel arrangements.

Toilet rooms should be of ample size and distributed so that in a three-story building approximately 60% of the fixtures are on the ground floor with 20% on each of the other floors. Separated as widely as possible. Toilets to have water-proof floor and wainscoting.

Showers should be provided for all buildings with gymnasium and should be in the ratio of 1 to 75 pupils.

Closets should be of best porcelain syphon jet type with automatic seat, operated flush valves, and should be installed in the proportion of 1 to 18 girls and 1 to 30 boys. Seats should be open front and back type. Urinals should be of the porcelain stall type 18 in. wide and set 3 in. apart to permit easy cleaning. Urinals should be in the proportion of 1 to 20 pupils. All closet-stall partitions should be of slate or metal. If of slate same to be 1⅛ in. thick. No doors need be provided for boys' stalls, but should be provided for girls' stalls.

One of the most important additions to our local schools was the installation of proper heating, electrical and sanitary facilities in our older schools. Some of these buildings were thirty years old or more, and while still serviceable from a purely housing standpoint, were equipped with heating, lighting and sanitary apparatus which was totally inadequate for their needs.

Most of the older schools were equipped with hot-air-heating furnaces numbering in some cases as high as ten to fifteen separate units and with their coal bins, occupied practically the entire area of the cellars. These units for the most part were located in open cellar with open wood joist ceilings, constituted a grave fire risk, and required a great deal of attention. The expense of handling and of maintenance were out of all proportion to the size school.

Many of the schools were also used for night classes for special courses and were in some cases equipped only with gas fixtures of primitive type. Such buildings as were wired, had in general, because of inadequacy of funds, been wired in wood moulding or open cleat work construction, also constituting a great fire hazard. Practically none of these buildings further were equipped with modern lighting fixtures.

No plumbing further in many cases, was provided beyond outdoor privies and even where located inside of building, the plumbing was often of the most primitive open-trough closet type and standing slate urinals of the overflow type. All partitions between closets, etc., were also of wood, contrary to good practice, and no artificial ventilation was provided, making the rooms extremely foul.

The maintenance on systems of the above type was steadily mounting year after year and was requiring more and more replacements.

The city in attempting to correct some of these evils adopted the committee system as above and agreed on types of heating, electrical and sanitary systems to be installed. At the same time requirements, as to ventilation of the class room, ratios of plumbing fixtures to pupils, etc., were all agreed upon and the plans drawn on this basis. It has further been decided that all wiring in these older buildings be placed in metal raceways to eliminate as far as possible the fire risk from this source.

As many of the buildings are quite old and will probably be replaced from time to time, the general heating and ventilating systems, ratios of plumbing fixtures, etc., were not installed on the same basis as adopted for new buildings. All work was installed, however, to give a reasonable degree of ventilation, satisfactory heating and sanitary facilities, and adequate lighting for all buildings. All boilers and coal-storage spaces are being made fireproof as far as possible. All toilets are being adequately ventilated mechanically, and all partitions between fixtures will be slate or metal.

Lighting fixtures for the older buildings will be of the type noted for new work as above.

Standpipes will also be added to several of the buildings as will also be the case with fire-alarm systems.

This is about as far as we can carry the improvements in general on existing work, altho where some buildings are in exceptionally poor state, as to building proper, some of the items listed in the requirements for new buildings can be embodied at relatively small cost, and these additions should also be made.

In concluding this paper it should be understood that no attempt has been made to cover in the same each and every one of the items of construction or equipment necessary for a satisfactory and efficient school. It has only been the intention to point out some of the fundamental requirements and proportions which have been found thruout the country to give better facilities in school housing, and to emphasize the fact that where so many items concerning the wellfare of pupils are involved, the responsibility of providing the necessary facilities should not be left to the single individual.

THE RELATIONS BETWEEN PUBLIC SERVICE COMMISSIONS AND MUNICIPALITIES

By Ezra B. Whitman, State Public Service Commissioner, Baltimore, Md.

In order to cover thoroly the subject of the relations between municipalities and Public Service Commissions, it would be necessary to study the laws of every State in the Union where Public Service Commissions have been established. The writer has not had the time to make such an exhaustive study, but has confined himself to his own experience and such studies as he has made in his brief term as Public Service Commissioner in the State of Maryland. The three principal functions of Public Service Commissions are the regulation of rates, service and finances.

In some states the rates are filed by the corporations with the commissions and may be raised or lowered by the corporations without the consent of the commissions. These rates fixed by the corporations can be reviewed by the commissions at hearings ordered by the commissions themselves or called upon complaint of the city officials or upon the petition of one hundred or more citizens. In Maryland, if a rate is once fixed by order of the commission, it cannot be changed by the corporation during the term of the order without the consent of the commission. The theory of such regulation is that the corporations shall have full control over the management of their affairs and that the commissions shall function only where the corporations are conducting their operations in a manner inimical to the best interests of the public.

In other states the laws are such that no rates can be fixed without the consent of the commissions. The prime objection to this method of regulation is that conditions change so rapidly, and this has been particularly true in the last five or six years, that, before the valuations of the physical and intangible properties of the companies and the operating expenses and fixed charges can be ascertained and other information be obtained necessary in fixing a rate which will give the needed increase, the corporations have been forced into the hands of the receivers.

There is no question but that there has been considerable justification of this objection, and during the war and the first two years of high prices after the war when costs were soaring higher and higher, the public service corporations had an extremely difficult time. The results of these difficulties are evident in the rapid decline in the values of public utility securities.

Many corporations have finally succeeded in securing raised rates and with the fall in operating costs during the past year, they are showing signs of recovery of earning power. Such recovery is of extreme importance to the welfare of our municipalities, particularly those which are growing rapidly. This rapid growth requires the expenditure of millions of dollars to meet the demands for new transportation facilities, and the extension of gas, water and electric mains and services.

The money for such extensions can be obtained only if the credits of the companies are in sound condition, which is true only when the earnings show a fair rate of return on the fair value of the property. Public service corporations cannot secure needed funds by taxation or any other compulsory method but must secure money needed for development from individuals and corporations who are willing to invest their money in these enterprises.

As you all undoubtedly know, money is commanding much higher rates of interest at the present than during the pre-war period, and the public service corporations, in securing their money, must compete with the large railroads and municipalities in foreign countries, which are offering high grade bonds and securities, paying rates of interest of from seven to eight percent. Therefore, at the present time, the public service corporations, in order to compete for money, must show higher rates of return than were shown before the war.

In regard to the question of service, public service commissions are given the powers to see that the utility corporations furnish proper and adequate service. This not only refers to the community as a whole but to each individual within the community, and constant individual complaints are being received which must have the attention of the public service commissions. The questions of quality of service and adequacy of the service of telephone companies, street railway transportation, gas and electric companies, steam heating companies, and the railways in their intrastate business are questions which vitally affect the welfare of the municipalities. A paper could be written upon this subject alone, dealing with the service of public utility corporations as regulated by the public service commissions and the relations of such service to the municipalities, but I simply call your attention to the importance of securing good and adequate service from the corporations in order to prevent the welfare of the municipalities from suffering serious harm.

In regard to the financing of the public utility corporations, the public service commissions must pass upon every issue of securities of any kind, and determine whether or not the proceeds from such securities will be used for proper corporate purposes. The commissions must be informed of the market value of the securities in order to see that they are sold for a proper figure. After the securities are sold and the money is received by the corporations, the public service commissions then require statements to be made to them, showing that the funds so received are expended in a proper and legitimate manner. It is practically impossible under the present methods of regulation for an inside ring in the management of a corporation to sell the securities of a public utility corporation and put the proceeds of such sale in their pockets as was possible twenty to twenty-five years ago before regulation by the states was started.

As a rule, the public service commissions have little direct jurisdiction over the affairs of the municipalities. In Maryland, the only jurisdiction its commission has power to assume is in those cities and towns where electric power is manufactured and sold by the local governing body to the public. As long as current is made and used only for public purposes, the commission has no jurisdiction, but if electricity is sold to the public, then municipalities must file their schedules of rates with the commission, and these rates can be modified by the commission after a hearing, which can be ordered by the commission or upon application to the commission for a hearing by one hundred or more complainants.

In some of the states, the public service commissions have control, not only of private water companies, but of the public water companies, and they control the making of rates and the service that are given to the public. The speaker, while attending the convention of the American Water Works Association in Cleveland last June, heard speak one of the chief engineers of a public service commission in one of the Western States, where the control of both private and public water supplies is in the hands of the commission, and it was very interesting to learn that their commission had far more difficulty in dealing with the municipalities which controlled their water supplies than it did in dealing with the privately owned companies.

The passenger transportation problem in our cities is one of the most important that confronts both the municipalities and the public service commissions at the present time. A number of old franchises granted by the municipalities limited the carfares to a maximum of 5 cents, and this has led to very serious difficulties for the street-railway companies where the municipalities had been in control of the politicians seeking votes rather than keeping the best interests of the community as a whole as the controlling factor in their actions.

As a striking contrast as to how this problem has been met in different cities, I would like to mention the two widely separated cities of Macon, Georgia, and Des Moines, Iowa. At Macon, the railway companies were operating under franchises which fixed the maximum fare at 5 cents. After we entered the war and the cost of operation rose, the street railway companies laid the case before the council and the council promptly granted them an increase of fare to 6 cents. This increase did not prove sufficient to meet the needs of the companies with the cost mounting ever higher and higher, and it was necessary to go before the council again and ask for an increase to 7 cents. Upon it being demonstrated that this increase was actually needed, the council granted the increase in fare, and the Macon Street Railways Company has weathered the hard times of the war and, I am informed, is in fairly good shape.

At Des Moines, Iowa, the street-railway company requested an increase from the mayor and council, which increase was refused, altho it was demonstrated that it would be impossible for the street railway system to continue operation with a 5-cent fare. The action of the council threw the company into the hands of receivers, and the Federal judge ordered an increase of fare from five to eight cents. In retaliation for this increase of fare, the city authorities granted permits indiscriminately to jitney busses of every kind and description, charging them no taxes of any kind and submitting them to no regulation whatsoever. The operation of these jitney busses, which took the cream of the traffic from the street railway, soon produced conditions that made it impossible for the street railway to earn its operating expenses even with an 8-cent fare, and, in August, the Federal judge authorized the street railway company to cease operation.

The people, who were in sympathy with the jitney busses during the summer time, put up with the inconvenience of crowded busses and poor service. As cooler weather came on, the sympathy of the people began to change, and they became tired of the poor service and the necessity in many cases for walking and the discomforts of riding in open automobiles. It has recently been reported in the newspapers that the trolley lines will resume operations upon terms satisfactory to the street railway company.

Our municipalities must deal with the problem of transportation as a business affair and not as a political question. As soon as it becomes a political question, the public is sure to suffer.

The proper regulation of jitney bus lines is a problem that the municipalities must face. It has been thoroly demonstrated not only in Des Moines, but in Bridgeport, Connecticut, and Toledo, Ohio, that it is impossible for our street-railway systems to operate with indiscriminate competition from jitney lines. These bus lines usually pick out the heaviest traveled and shortest routes in the city, and with these short hauls and full busses operating only during the peak hours of the day, they make such serious inroads on the income of the street-railway lines that it is practically impossible to operate the street-railway system excepting at a loss.

This problem is receiving serious attention thruout the country. Fortunately, here in Baltimore there is only one jitney bus line in the city, and the Public Service Commission of the State of Maryland has refused to issue permits for other bus lines to operate, feeling that it is impossible to have both jitney busses and street railway, and that the best interests of the community demand that the transportation within the city shall be as far as possible in the hands of one company instead of competing companies. We feel that if certain sections of the city require the operation of busses that these busses should be operated by the street-railway company.

The officials of the United Railways and Electric Company of Baltimore have been giving serious study to the question of operating busses and trackless trolleys, and the president and general manager of the company made a trip to Europe this summer to study the operations of bus lines and trackless trolleys which have been much further developed in Europe than has been the case in this country.

Your public service corporations are factors of a vital importance to the prosperity of any municipality. Where you have a good street-car system, gas manufactured and sold at a low rate and electricity manufactured and sold at a low rate, the city will attract industrial enterprises and its material prosperity will consequently be enhanced. It is absolutely necessary for the welfare of the municipalities that these extremely important corporations be treated with fairness in order that they may earn a sufficient return to attract those with money to invest, which money can be used in developing these properties.

The only alternative is municipal ownership. The writer does not believe that municipal ownership of public utilities, under the conditions prevailing up to now, will be for the best interests of the public.

The welfare of these corporations is largely within the hands of the public service commissions, and I believe that in general they are conscientiously trying to solve the difficult problems which come before them so as to be fair, both to the public and to the corporations. The public service corporations have the advantage of being able to secure the greatest experts in the country and to present their problems in the best possible light before the public service commissions. The public, as a rule, is not adequately represented at the hearings of the public service commissions. On the other hand, the tremendous weight of public opinion is against the public service corporations and the commissioners will hesitate to grant any increase or privileges to the corporations on account of the unpopularity of such acts. A public service commissioner must make up his mind that he is unpopular in times of rising operating costs which require increased rates to the public utility corporation, and I know that the commissions will welcome the time when costs have fallen to such an extent that prices for services rendered by the public utility corporations can be reduced.

DISCUSSION

A MEMBER: Why don't our public service corporations help out the people with jitneys at 5 cents? Why don't they put on motor busses and take big loads themselves? It is a much cheaper mode of transportation. Why don't they consider that and place busses in the zones between their lines and stop the surplus railways in our cities which are such a nuisance to pavements; and why don't they use the cheaper known mode of transportation to hold their business?

MR. WHITMAN: The busses, if they are operated in the same way the street cars are running, on the long-route hauls as well as the short-route hauls are more expensive. The motor busses pick out the favored routes.

COLONEL HOWARD: Bus transportation is a means of relieving the heavy peak loads.

MR. WHITMAN: Our commission believes that is the solution, that where the busses should be operated they should be operated by the city railways.

MR. HOWARD: In regard to gas rates; in New York 52,000 women are cooking one hour longer nowadays in order to put the proper thermal units, into their cooking to do it properly. The B. t. u. have been reduced to 525 and they used to be 600. The result is that it takes much longer to cook than it did before. That is the reason it is so unpopular. It takes 52,000 women per day one hour longer in order to cook the food properly.

MR. MULLEN: The speaker brought up, at the end of his address, the matter of public versus private ownership; and spoke in favor of private ownership. There are several points I would like to raise.

Prior to the war, I was in the city of Cleveland, talking with Mr. Baker and Mr. Springborn. Mr. Springborn was telling me of Cleveland's fine street-railway system; how well it operated, and that they got the result by guaranteeing the company 6 percent dividends on its stock, or upon the valuation. I asked him then what interest rate Cleveland was paying on its waterworks, and he said it was 4 percent.

In other words, there is an inefficiency in money service to the extent of the difference between 4 percent and 6 percent; and it will take a lot of the much advertised inefficiency of labor to overcome that item of the high cost of money service in the street-railway company's disbursements.

Money service was costing the water works 33⅓ percent less than it was costing the railway company; or, inversely stated, it was costing the railway company 50 percent more than it was the water works. Money service, I am informed, is a very big item in the expenditures of both water works and street railways.

The second point is this: I have never been able to see the necessity for the tender feeling that some of us have towards public service corporations, which leads us to guarantee them dividends. I was once a contractor myself,—and a street-railway franchise is nothing more nor less than a contract,—and I don't remember that, if I lost money on a contract, or any other contractor did, some one told us we had to be taken care of by a guarantee of 6 percent interest on our money.

The third point I would like to make in opposition to this attempt to keep private corporations permanently on our backs in municipal affairs, where the economic direction and natural public interest are towards public ownership, is this: I have never yet known or heard of a municipal waterworks that corrupted a city government; and that is one point I would like to have sink in.

MR. WHITMAN: I simply want to reply to the point where the speaker referred to the contractor never having guaranteed to him a 6 percent return on his money. As a contractor, when his business was bad, he could stop and cease operations. With a public service corporation, when business is bad, they cannot cease operations and wait for business to improve. They have got to continue to operate regardless of whether business is good or bad. When business is good, and other people are raising their prices, increasing their profits, the public service commissions refuse to let the corporations make a very large return upon their money.

A MEMBER: In what states has that happened?

MR. WHITMAN: Maryland: The rates are fixed and they cannot change them. The two points, the fact that the public service corporations are not permitted to make very large earnings when business is good, as other corporations are, and that they cannot cease operations when business is bad, I think are a complete answer to the fact that the private business man does not have six percent guaranteed to him.

MR. MULLEN: I object to that. It is no answer at all. There is a contractor in Quebec Province today who has a contract for a large mileage of roads. He is losing money; but he must complete that contract. He cannot stop. If he does not complete the work, he goes into bankruptcy. There is no reason why the street-railway company should not go into bankruptcy and be bought out by the City at a lower valuation. There is no reason why the large corporation should have preferential treatment.

MR. NORTON: Last evening we heard with great pleasure of your elegant park system. Does the Major care to say anything about the effect of the payment of the 9% gross for the park, the effect upon the traction situation in Baltimore?

MR. WHITMAN: The effect of the 9% park avenue is almost a cent in street-railway fares, and I believe in Cleveland, if I am correctly informed, the street-railway system has practically been relieved of the payment of special taxes and also for paving, and it is also a question as to where you want to put your taxes, because those costs return to the people thru the public-service corporations. Or they are taxed directly. Now, will you tax them directly or make them pay thru the public service corporations?

MR. NORTON: Then Major, the extra cent which is paid by the rider is paid largely by the people who are compelled to ride on the street car rather than by the larger number who are able to enjoy the benefits of your park by driving?

MR. WHITMAN: Yes.

MR. SPRAGUE: This discussion and the paper which has been read by the speaker seems to relate more or less to the relative economies in the transportation of passengers, the automobile or the jitney bus on the one side as against the street car on the other. That proposition is not new in Pittsburg and it was found there that it was much cheaper to burn coal than it was gasoline and the jitneys were very short lived and went out of business.

MR. G. J. WAGNER: As I view this matter, the difficulty seems to be to get the valuation and rate of return high enough so that these companies will be refinanced. It seems that the public service corporations in many cities are so highly bonded that when refinancing comes they cannot refinance. The policy in the several commissions seems to differ as to what valuation and rate of return they shall have in order that they may refinance, and also in order that they may get money for new extensions. I am wondering what policy they are pursuing in Maryland in order to co-operate and bring together these two things, the refinancing and getting the money for extensions. How have they solved this problem?

MR. WHITMAN: I might say that the rate of return is fixed by by the commission according to the law. There has to be a fair return on the fair value of the property and, regardless of what the amount of stocks or bonds may be in the corporation, we endeavor to fix the rate of return on the fair value of the property. As to what is the fair value of the property, at the present time there is a great deal of difference of opinion. The Commission in Maryland has almost uniformly adopted the method of valuation of practically taking the prudent investment theory. That is, as far as possible basing the rate of return on the money which has actually been invested in the property. For instance, if a valuation was made in 1912, then the rate of return would be fixed on the valuation of the property as of 1912 plus additions and betterments to the Company and the money they have actually spent in development of the property, and that fair rate of return must give the company sufficient money to do their financing and everything else that they have to do. Operation and financing and everything else must come out of the proceeds of that fair rate of return on the fair value of the property.

MR. WAGNER: Is it not true that most of these companies, Pittsburg and some of the other large companies, have such great bond issues that when you finally get the historic value and allow them a fair rate of return on that, you get such a small revenue that under their mortgages they cannot issue another dollar's worth of bonds? I believe absolutely in state regulation of gas companies, but I do not see how the public service commission is going to solve the problem for street railways. If a public service commission gives the same valuation and the same rate of return, equitably determined for a street railway, which has so much superseded property and is so highly bonded, how are they going to get a dollar to make the proper extensions in the future.

The question is whether it would be better for a municipality to make a deal directly with the company whereby the extensions and rehabilitations necessary in the property can be made or whether the entire matter should be referred to the State utilities commission. If referred to the State utilities commission, that commission according to precedent would only give a valuation and rate of return which would not take into account the rehabilitating of the property or the need for extensions.

City Planning has shown that one of the most important elements of a city is the proper laying out of transportation facilities, and unless the company is allowed to earn sufficiently they will not be interested in extensions and the rebuilding of the property according to the demands of the city.

I am wondering whether your commission has solved this particular point of how to handle these companies where they are so overbonded, and where the mortgages are such that they cannot borrow any money.

MR. WHITMAN: The question of making extensions by the street railway system is a very difficult one at the present time. We are hoping that that problem will be taken care of by busses and trackless trolleys where they do not need the large investment that is needed where you lay tracks and where you have to pay for paving between the tracks and on either side. If we can make the extensions in that way it will not need near the amount of capital that will be needed if they put down street-car tracks.

MR. SPRAGUE: The Public Service Commission of Pennsylvania had an appraisement valuation of the properties made and as a result of that valuation the commission fixed a value for the property. That valuation does not represent the bonded indebtedness of the company and as a result there will be about $60,000,000 drawn off in water. The company is now in the hands of receivers, to be reorganized on the basis of the valuation as determined by the Commission. When that is done the company will then be in a position to invite new capital and make the necessary extensions which the transportation necessity demands.

MR. MULLEN: I have said so much in disagreement with Mr. Whitman that I would now like to say a word in agreement with him. I am thoroly in accord, and I think engineers necessarily must be, with the elimination of competition in services which are natural monopolies, municipal services particularly; and I think the establishment of bus lines in any city is one of the worst things that can be done, in the public interest, unless it is as a temporary war measure directed by the city and the public service corporation, the street railway company.

The bus lines, as they are operating today, and also the autotruck freight transportation lines that are in competition with the railroads, are operating without paying a suitable proportion of the cost of the right of way and the roadbed over which they are travelling. Until we devise some means of estimating this cost, and of making the automobile truck and the jitney pay equitably for the use of the right of way over which they operate, we will not have an economic adjustment between street railway and bus passenger transportation, or between railroad and autotruck transportation.

There are now measures in some of the states for taxing gasoline. This seems to be a just way of raising funds for the purpose of both building and maintaining roads. Until such an equitable method of making the traffic on public highways pay for the road values consumed, along with the gasoline, there is no way of telling what is the economic advantage to the community between automobile, jitney, and autotruck transportation as against street railway and railroad transportation.

The present conditions operate as a subsidy to automobile transportation and as a handicap to rail transportation.

MR. BASCOM: There has been imposed in the state of Pennsylvania a tax of one cent per gallon on gasoline. That goes to the state. The local municipality does not get a part of it.

I have in mind a traction company that has perpetual franchises operating in 64 different municipalities. Their original franchise called for the maintenance of the pavement between the tracks, between the rails and two feet on the outside thereof; in some municipalities it was only eighteen inches. The company has been hard hit by the maintenance of the roadbed. This company went thru the "water-drawing" process some years ago. The original fare was 5 cents, and I have in mind rides that were 7 and 10 miles long, for 5 cents. The scheme in Pennsylvania is to file a rate. If there is no protest by a municipality or citizens within thirty days, the rate becomes effective. It is not investigated by the public service commission. The commission simply approves the rate without investigating it unless there is a protest. But there is little chance of the municipality or a board of citizens investigating that rate. This is not a case of fares entirely. It is a case of zones as well as fares. In one case where there was a nine or ten-mile ride for 5 cents, the fare is now 28 cents; four zones at 7 cents each.

The Public Service Commission recognizes a fair return on value. Sometimes it is reproduction value and sometimes it is the historic value or actual cost. In Pennsylvania the fair return is generally adjusted at 7%, not 6% as in Maryland.

I think there is not enough consideration given to the zones. It is similar to the taxation situation. What is the difference whether you have a high tax rate and a low valuation or a low tax rate and a high valuation? They all seem to think the one important thing is the rate without taking into consideration the zones.

MR. MACALLUM: There is one point I want to refer to: that is, the relative cost of operating street cars and busses. In Glasgow they found the cost per mile was just twice for a bus that it was for operating a street car.

MR. BASCOM: In regard to the trackless trolley. I know of an inquiry for 25 trackless trolleys for a certain city in this country to overcome the paving situations. I believe one state in the Union has already by a legislative act relieved the traction companies from the original franchises in maintaining pavements and it is very active in certain other states. I believe the solution of the whole proposition is the trackless trolley. The same thing is being considered on branch lines of the steam railroads. I know of one company that has placed an order for gasoline locomotives to haul three cars at a rate of 35 miles per hour, to be operated by one man, on the feeder lines where it does not pay to operate with the heavy investment of coal-steam power.

SPECIFICATIONS FOR BRICK PAVING

Adopted by the Society in Convention October 27, 1921, and by letter ballot as shown in report of Canvassing Committee on page 425.

1. *Character of Brick*

Quality. Vitrified paving brick shall be evenly burned, thoroly annealed, regular in size and shape and when broken shall show uniformity of texture and structure and be free from open or marked laminations.

Size. General. Brick shall be of the following sizes and shall not vary one from another more than one-eighth (⅛) of an inch in width and depth and not more than one-half (½) of an inch in length. Measurements apply to the body of the brick and do not include lugs.

Repressed with Lugs. Three and one-half (3½) inches in width by four (4) inches in depth by eight and one-half (8½) inches in length. Edges of brick shall be rounded, the radius not exceeding three-sixteenths (3/16) of an inch. Brick shall have not less than two (2) and not more than four (4) projections or lugs that shall project not more than one quarter (¼) of an inch nor less than one-eighth (⅛) of an inch from the body of the brick. Projections or lugs, measured at the base of the lug, shall not exceed in total area one-eighth (⅛) the total area of the face of the brick.

Hillside Repressed with Lugs. Three and one-half (3½) inches in width by four (4) inches in depth by eight and one-half (8½) inches in length. Edges of brick shall be rounded, the radius not exceeding three-sixteenths (3/16) of an inch. Brick shall have not less than two (2) and not more than four (4) projections or lugs that shall project not more than one quarter (¼) of an inch nor less than one eighth (⅛) of an inch from the body of the brick. Projections or lugs, measured at the base of the lug, shall not exceed in area one-eighth (⅛) the total area of the face of the brick. One edge of brick shall be chamfered longitudinally not more than three quarters (¾) of an inch on the four (4)-inch face and not more than one (1) inch on the adjoining three and one-half (3½)-inch face.

Wire-Cut with Wire-Cut Lug. Three and one-half (3½) inches in width by four (4) inches or three (3) inches in depth by eight and one-half (8½) inches in length. All edges of the brick shall be square. Ends of the brick may be double beveled not to exceed three thirty-seconds (3/32) of an inch. Brick shall have not less than (2) nor more than four (4) projections or lugs that shall project not more than one quarter (¼) of an inch nor less than one-eighth (⅛) of an inch from the body of the brick. Projections or lugs, measured at the base of the lug, shall not exceed in total area one-eighth (1/8) of the total area of the face of the brick.

Hillside Wire-Cut with Wire-Cut Lugs. Three and one-half (3½) inches in width by four (4) inches or three (3) inches in depth by eight and one-half (8½)-inches in length. All edges of the brick shall be square. Ends of the brick may be double beveled not to exceed three thirty-seconds (3/32) of an inch. Brick shall have not less than two (2) nor more than four (4) projections or lugs that shall project not more than one-quarter (¼) of an inch nor less than one-eighth (1/8) of an inch from the body of the brick. Projections or lugs, measured at the base of the lug, shall not exceed in total area one-eighth (1/8) of the total area of the face of the brick. One of the three and one-half (3½)-inch faces shall be provided with not less than two (2) and not more than three (3) complete grooves extending transversely across the brick. Grooves shall each be not more than one-half of an inch (½″) in depth nor more than one-half an inch (½″) in width on the surface of brick. At the end of brick a half groove shall be provided so that two brick in place shall provide a full groove.

Wire-Cut with Lugs. Four (4) inches in width by three (3) inches in depth by eight and one-half (8½) inches in length. Edges of the brick shall be square. Ends of the brick may be double beveled not to exceed three thirty-seconds (3/32) of an inch, and the four (4)-inch sides shall be wire cut. Brick shall have not less than two (2) and not more than four (4) projections or lugs that shall project not more than one-quarter (¼) nor less than one-eighth (1/8) of an inch from the body of the brick. Projections or lugs, measured at the base of the lug, shall not exceed in total area one-eighth (1/8) of the total area of the face of the brick.

Special Brick. Brick to meet special or extraordinary conditions may be ordered by the engineer in such shapes as are desired, subject to the ability of the manufacturer to make same.

II. *Inspection*

(A) *Visual Inspection.* Visual inspection shall be made as follows:*

All brick shall be subject to thoro inspection subsequent to their delivery at the place of use and prior to or during laying and shall be culled out and rejected upon the following grounds:

All brick which are broken in two or chipped in such a manner that neither wearing surface remains substantially intact, or that the lower or bearing surface is reduced in area by more than one-tenth (1/10). Where brick are rejected upon this ground, it shall be the duty of the contractor to use them so far as practicable in obtaining the necessary half-bricks for breaking courses and making closures.

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* See Standard Specifications for Paving Brick, American Society for Testing Materials, Serial Designation C-7-15.

All brick which are cracked in such a degree as to produce defects such as are defined in above paragraph, unless such cracks are plainly superficial and not such as to weaken perceptibly the resistance of the brick to its conditions of use.

All brick which are so off-size or so mis-shapen, bent, twisted or kiln-marked that they will not form a proper surface as defined in paragraph 14 of these specifications or aline with other brick without making joints other than those permitted in paragraph 11-A of these specifications.

All brick which are obviously too soft and too poorly vitrified to endure street wear. When any disagreement arises between city and contractor under this item, the city shall make two or more rattler tests of the brick which it wishes to exclude, and if in these tests certain brick fall beyond the maximum rattler losses permitted under paragraph 6 of these specifications then all brick having the same objectionable appearance shall be excluded.

All brick which differ so markedly in color from the type or average of the shipment as to imply differences in the material of which the brick are made, or extreme difference in manufacture.

(B) *Factory Inspection.* Factory inspection of the brick shall be made as defined in paragraphs 3, 4 and 6 of these specifications.

(C) *Inspection After Delivery.* Inspection after delivery shall be made as defined in paragraphs 3, 4, 5 and 6 of these specifications.

The city shall elect whether it will require a factory inspection or an inspection after delivery.

Should the city require a factory inspection, the engineer reserves the right to run additional tests on delivered brick and the factory test shall not constitute final acceptance.

III. *Rattler Test for Brick*

Samples. Samples of brick of uniform shape and appearance shall be taken from each car tested (estimated at 10,000 brick) or from each 10,000 brick in kiln or stock pile. Brick having a defect that would reject them shall not be used. Three grades of samples shall be tested—one of the softest, one of the medium and one of the hardest burned. If all of the tests over-run the specified percentage of loss the car or kiln shall be rejected. If one or two of the tests over-run, another test of said grade or grades will be made. Should one of these retests over-run the specified percentage of loss, the contractor may cull said grade, provided they do not exceed ten (10) per cent. of the amount of brick represented by the tests, and deliver the balance on the improvement. Otherwise, the whole lot will be rejected.

In order to prevent the continued shipments of inferior brick, only two cars of two separate shipments of any make of brick will be tested. Should they fail to meet the requirements stated above said make of brick will be rejected for this improvement.

IV. *Number and Condition of Brick*

Ten (10) paving brick shall constitute the number to be used in a single test. Brick shall be thoroly dried for at least three (3) hours in a temperature of at least one hundred (100) degrees Fahr. before testing.

V. *Test Before Unloading*

The Contractor shall notify the proper city official of location and car number of each car-load of brick received so that samples, if deemed necessary, may be taken and tested by the city and brick shall not be delivered on or adjacent to any improvement on which the brick are to be used until a written statement has been received from the engineer, or his authorized representative, that they have been inspected or have passed the required tests. Decisions relative to each car-load will be made within 24 hours of notice. Permission to deliver brick on line of work shall not be considered a final inspection in any respect.

VI. *Making the Rattler Test*

The rattler, rattler test and record data shall conform to the requirements adopted by the A.S.M.I. in 1914 and all subsequent amendments and modifications thereto as follows:

The Rattler. The machine shall be of good mechanical construction, self-contained, and shall conform to the following details of material and dimensions, and shall consist of barrel, frame and driving mechanism as herein described.

The Barrel. The barrel of the machine shall be made up of the heads, headliners and staves.

The heads shall be cast with trunions in one piece. The trunion bearings shall not be less than two and one-half (2½) inches in diameter or less than six (6) inches in length.

The heads shall not be less than three-fourths (¾) inch thick nor more than seven-eighths (⅞) inch. In outline they shall be a regular fourteen (14)-sided polygon inscribed in a circle twenty-eight and three-eighths (28 ⅜) inches in diameter. The heads shall be provided with flanges not less than three-fourths (¾) inch thick and extending outward two and one-half (2½) inches from the inside face of head to afford a means of fastening the staves. The flanges shall be slotted on the outer edge, so as to provide for two (2) three-fourths (¾)-inch bolts at each end of each stave, said slots to be thirteen-sixteenths (13/16) inch wide and two and three-fourths (2¾) inches center to center. Under each section of the flanges there shall be a brace three-eighths (⅜) inch thick and extending down the outside of the head not less than two (2) inches. Each slot shall be provided with recess for bolt-head which shall act to prevent the turning of the same. There shall be for each head a cast-iron headliner one (1) inch in thickness and conforming to the outline of the head, but inscribed in a circle twenty-eight and one-eighth (28⅛) inches in diameter. This liner or wear plate shall be fastened to the head by seven (7) five-eighths (⅝)-inch cap-screws, thru the head from the outside. These wear plates, whenever they become worn down one-half (½) inch below their initial surface level at any point of their surface, must be replaced with new. The metal of which these wear plates are to be composed shall be what is known as hard machinery iron and must contain not less than one (1) per cent. of combined carbon. The faces of the polygon must be smooth and give uniform bearing for the staves. To secure the desired uniform bearing the faces of the head may be ground or machined.

The Staves. The staves shall be made of six (6)-inch medium steel structural channels twenty-seven and one-fourth (27¼) inches long and weighing fifteen and five-tenths (15.5) pounds per linear foot.

The channels shall be drilled with holes thirteen-sixteenths (13/16) inch in diameter, two (2) in each end, for bolts to fasten same to head, the center line of the holes being one (1) inch from either end and one and three-eighths (1⅜) inches either way from the longitudinal center line.

The spaces between the staves will be determined by the accuracy of the heads, but not exceed five-sixteenths (5/16) inch. The interior or flat side of each channel must be protected by a lining or wear-plate three eighths (⅜) inch thick by five and one-half (5½) inches wide by nineteen and three-fourths (19¾) inches long. The wear-plate shall consist of medium steel plate and shall be riveted to the channel by three (3) one-half (½)-inch rivets, one of which shall be on the center line both ways and the other two on the longitudinal center line and spaced seven (7) inches from the center each way. The rivet holes shall be counter-sunk on the face of the wear-plate and the rivets shall be driven hot and chipped off flush with the surface of the wear plate. These wear-plates shall be inspected from time to time and if found loose shall be at once re-riveted, but no wear-plate shall be replaced by a new one except as the whole set is changed. No set of wear-plates shall be used for more than one hundred and fifty (150) tests under any circumstances. The record must show the date when each set of wear-plates goes into service and the number of tests made upon each set.

The staves when bolted to the heads shall form a barrel twenty (20) inches long, inside measurement, between wear-plates. The wear-plates of the staves must be so placed as to drop between the wear-plates of the heads. These staves shall be bolted tightly to the heads by four (4) three-fourths (¾)-inch bolts and each bolt shall be provided with lock nuts and shall be inspected at not less frequent intervals than every fifth (5th) test and all nuts kept tight. A record shall be made after each such inspection, showing in what condition the bolts were found.

The Frame and Driving Mechanism. The barrel shall be mounted on a cast-iron frame of sufficient strength and rigidity to support same without undue vibration. This shall rest on a rigid foundation and be fastened to same by bolts at not less than four points.

It shall be driven by gearing whose ratio of driver to driven shall not be less than one (1) to four (4). The countershaft upon which the driving pinion is mounted shall not be less than one and fifteen-sixteenths (1 15/16) inches in diameter, with bearings not less than six (6) inches in length and belt driven and the pulley shall not be less than eighteen (18) inches in diameter and six and one-half (6½) inches in face. A belt of six (6)-inch double-strength leather, properly adjusted so as to avoid unnecessary slipping shall be used.

The Abrasive Charge. The abrasive charge shall consist of two sizes of cast-iron spheres. The larger size shall be three and seventy-five hundredths (3.75) inches in diameter when new and shall weigh when new approximately seven and five-tenths (7.5) pounds (3.40 kilos) each. Ten shall be used.

These shall be weighed separately after each ten tests, and if the weight of any large shot falls to seven (7) pounds (3.175 kilos) it shall be discarded and a new one substituted; provided, however, that all of the large shot shall not be discarded and substituted by new ones at any single time, and that so far as possible the large shots shall compose a graduated series in various stages of wear.

The smaller size sphere shall be, when new, one and eight hundred seventy-five thousandths (1.875) inches in diameter and shall weigh not to exceed ninety-five hundredths (0.95) pound (0.430 kilo) each. Of these spheres so many shall be used as will bring the collective weight of the large and small spheres most nearly to three hundred (300) pounds, provided that no small sphere shall be retained in use after it has been worn down so that it will pass a circular hole one and seventy-five hundredths (1.75) inches in diameter, drilled in cast-iron plate one-fourth (¼) inch in thickness, or weigh less than seventy-five hundredths (0.75) pound (0.34 kilo). Further the small spheres shall be tested after every ten tests, by passing them over such an iron plate drilled with such holes, or by weighing, and any which pass thru or fall below the specified weight shall be replaced by new spheres; provided, further, that all of the small spheres shall not be rejected and replaced by new ones at any one time, and that so far as possible the small spheres shall compose a graduated series in various stages of wear. If at any time any sphere is found to be broken or defective it shall at once be replaced.

The iron composing these spheres shall have a chemical composition within the following limits:

	Per Cent
Combined carbon—not less than	2.50
Graphitic carbon—not more than	0.10
Silicon, not more than	1.00
Manganese, not more than	0.50
Phosphorus, not more than	0.25
Sulphur, not more than	0.08

For each new batch of spheres used the chemical analysis must be furnished by the maker, or be obtained by the user, before introduction into the charge; and unless the analysis meets the above specifications, the batch of spheres shall be rejected.

The Test. The rattler shall be rotated at a rate of not less than 29½ nor more than 30½ revolutions per minute, and 1,800 revolutions shall constitute the standard test. A counting machine shall be attached to the rattler for counting the revolutions.

A margin of not to exceed ten revolutions will be allowed for stopping. In case a charge is allowed to run several minutes beyond its proper termination, and the loss incurred is still within the prescribed limits, then the test shall not be discarded, but the fact shall be entered on the record.

Stopping and Starting. Only one start and stop per test is regular and acceptable. If from accidental causes a test is stopped and started twice extra, and the loss exceeds the maximum permissible, the test shall be disqualified and another made.

The Results. The loss shall be calculated in percentage of the original weight of the dried brick composing the charge. In weighing the rattled brick, any piece weighing less than one pound shall be rejected.

The Record (*Description*). The operator shall keep an official book, in which the alternate pages are perforated for removal. The record shall be kept in duplicate, by use of a carbon paper between the first and second sheets, and when all entries are made and calculations are completed, the original record shall be removed and the carbon duplicate preserved in the book. All calculations must be made in the space left for that purpose in the record blank, and the actual figures must appear. The record must bear its serial number and be filled out completely for each test and all data as to dates of inspections, weighing of shot, and replacement of work-out parts must be carefully entered, so that the records remaining in the book constitute a continuous one. In event of further copies of a record being needed, they may be furnished on separate sheets, but in no case shall the original carbon copy be removed from the record book.

The blank form upon which the record of all official brick tests is to be kept and reported is as follows:

REPORT OF STANDARD RATTLER TEST OF PAVING BRICK

Identification Data (Serial No. —)

Name of firm furnishing sample....................................
Name of the firm manufacturing sample.............................
Street or job which sample represents.............................
Brands or marks on the brick......................................
Quantity furnished..................Drying treatment..................
Date received.......................Date tested.......................
Length...................Breadth...............Thickness.............

Standardization Data

Number of charges tested since last inspection........................
Weight of charge (after standardization)..............................
Condition of locknuts on staves.......................................
Condition of scales...
Ten large spheres...
" small spheres...
Total...
Number of charges tested since stave linings were renewed.............
Repairs (Note any repairs affecting the condition of the barrel)......

Running Data

	Time readings Hour, Min., Sec.	Revolution Counter Readings	Running Notes Stops, etc.
Beginning of Test..........			
Final reading..........			

Weights and Calculations

Initial weight of ten bricks..
Final weight of same..
Loss of weight......................Percentage loss....................

Note: (The calculations must appear)

Number of broken bricks and remarks on same...........................

I certify that the foregoing test was made under the specifications of........
...................................and is a true record.

Signature of Tester.....................

Date Location of Laboratory

The brick shall show an abrasion loss of not more than —— nor less than —— of their dried weight. (See note.)

The difference between the maximum and minimum loss shall not exceed 8% for brick from any one factory and used in any one improvement, and in no event shall the minimum loss be less than 16%.

Note;—The percentage of loss should be designated from observation and study of the nature and amount of traffic expected to use the street in question. The permissible losses from the best information now available for brick of either the regular or Hillside patterns may be as follows:

	Per Cent. Loss.		
	3½ x 4 x 8½	3½ x 3 x 8½	4 x 3 x 8½
For brick suitable for heavy traffic.	22	25	23.5
For brick suitable for medium traffic.	24	27	25.5
For brick suitable for light traffic.	26	29	27.5

VII. *Delivery of Brick*

Brick shall be carefully unloaded without spalling or otherwise damaging the brick. Brick shall be hauled to the site of the improvement at such a time with the approval of the engineer as will best expedite the work. Precaution must be taken to prevent mud, dirt, or other material from collecting on the brick. Should such condition exist the brick shall be cleaned before such bricks are laid in the pavement.

VIII. *Foundation*

See recommendations and specifications of Committee on Foundations. A.S.M.I.

IX. *Headers*

At all street intersections and end of paving where there are no abutting hard pavements, substantial headers preferably of stone shall be set flush with the pavement or countersunk not to exceed two (2) inches, if adjoining a soft pavement.

X. *Bed*

(A) *Sand.* Upon the prepared base, which shall be thoroly cleaned, shall be spread, to a depth of not more than one (1) inch and not less than one-half (½) inch after rolling, a bed of sand free from foreign matter except that it may contain not to exceed 8% of loam.

Grading. The sand shall be well graded all of which shall pass a one-quarter (¼)-inch Standard Mesh sieve.

Shaping. Bed shall be shaped to a true cross-section of the roadway by means of an approved templet so designed as to be easily drawn on curb or guide timbers.

Rolling. If specified, before shaping the bed it shall be dampened and rolled over its entire surface with a hand roller. The roller shall be not less than thirty-six (36) inches in diameter twenty-four (24) inches in width and shall weigh not less than ten (10) pounds per inch of width. The templet shall then be used to complete the bed.

Disturbance. Bed shall not be disturbed after shaping and rolling and prior to laying brick.

(B) *Cement Sand. Thickness.* Upon the prepared base, which shall be thoroly cleaned, shall be spread a cement-sand bed to a depth of not more than one inch (1″) and not less than one-half inch (½″).

Proportions. Bed shall be composed of one part portland cement and four parts sand.

Cement. Portland cement for the bed shall conform to the definition and meet the requirements of the Standard Specifications and Tests for Portland Cement of the A.S.T.M., serial designation C9–17 and all subsequent amendments and modifications thereof.

Sand. Sand shall consist of any material of silicious or igneous origin, free from soft friable material, shale or slate, vegetable or other organic matter. It shall not contain clay or silt in excess of five (5) per cent. and shall be uniformly graded from that which passes a one-quarter (¼)-inch mesh to that which will pass a No. 100 standard mesh sieve.

Mixing. The cement and sand shall be thoroly mixed in proportions specified until it is of uniform color thruout. It shall be dry when mixed and shall be kept dry until brick are placed, inspected and rolled. If necessary to use damp sand in order that the work shall not be unreasonably delayed, then only so much sand and cement shall be mixed and spread as can be covered with brick, inspected and rolled within one hour of the commencement of the operation.

Shaping. Bed shall be shaped to a true cross-section of the roadway by means of an approved templet so designed as to be easily drawn on curb or guide timbers.

Disturbance. Bed shall not be disturbed after shaping and prior to laying the brick.

(C) *Granulated or water cooled slag.*
Slag screenings.
Lime-stone screenings.
Crushed shells.

Under section 10, Sub-Division A, Sand, wherever the word *Sand* appears, substitute one of the above materials.

XI. *Laying the Brick*

(A) *Straight.* The brick shall be laid in straight lines on edge at right angles from curb to curb or from curb to rail, except in the case of hillside wire-cut lug brick as hereinafter provided. At intersections they shall be laid as directed. Brick shall be laid with the lug sides all in the same direction. Alternate courses shall be commenced with one-half (½) brick. Brick must be placed close together, both ends and sides, breaking joints at least three (3) inches. At every fourth course brick shall be driven together by means of sledge and suitable timbers and all thick brick shall be removed. At every fifteen (15) feet for the full width of pavement, this course shall be trued to a line at right angle to curb. Brick shall be laid with the best edge up. Broken, chipped or warped brick, not suitable to lay as a whole, may be used for batting.

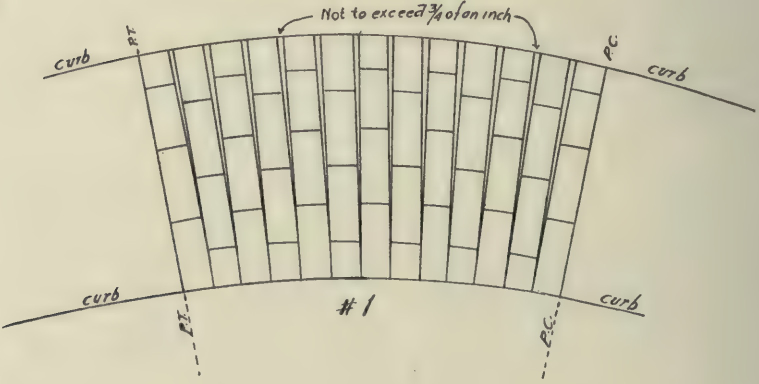
Hillside wire-cut lug brick shall be laid in courses parallel with the curb with the better face up and lugs turned in same direction. Alternate courses of brick shall be commenced with one-half brick and shall be completed by batting at the end of courses as hereinafter specified. On the last course of brick laid nothing but whole brick shall be used except for closures. Attempt shall not be made to bring the hillside grooves in the brick into alinement across the pavement.

Broken Brick. No bats or broken brick shall be used except at curbs, headers or at street car tracks. They shall be cut square with the top and sides of the brick. Batting for closures shall immediately follow the laying of the full-sized brick and the fractured end of cut or trimmed brick shall be turned toward the center of the roadway. Each course shall be completed by batting in at the end if required, using bats not less than three (3) inches in length, a portion of the next adjoining brick being broken off if necessary to give the minimum three (3)-inch bat at the end of the course.

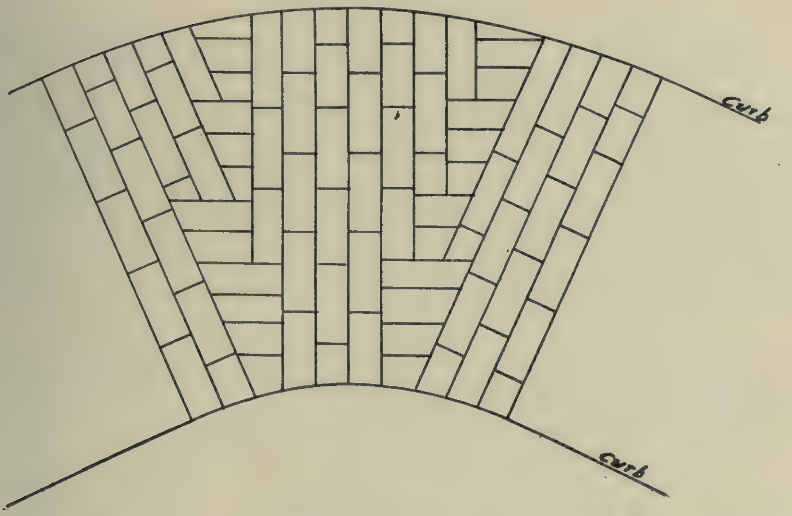
Intersections. The brick shall be laid thru street intersections at right angles to the line of curb, in place of using the herringbone or diagonal type of intersection.

(B) *Around Curves.* At curves brick shall be laid as directed by the engineer. The following suggestions are offered:

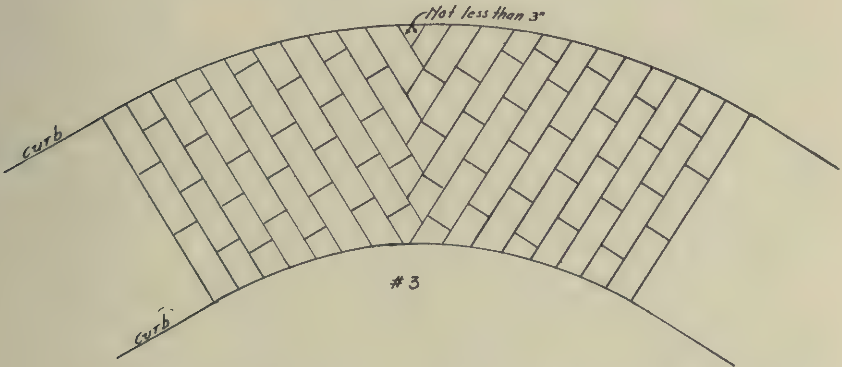
Method No. 1. Where the curvature of the street permits the brick shall be laid radially, except in the case of hillside wire-cut lug as hereinbefore provided, allowing at the outside of the curb a spacing between the courses exceeding that permitted where the street is straight. In no case, however, shall the spacing between courses of the brick on the outside of the curve exceed three-quarters of an inch (¾). Distance measured along the curb on the outside of the curve from the P. C. to the P. T. of same shall not be more than 13% greater than the corresponding distance on the inside of the curve. The radius of the outer curb line shall not be more than 13% greater than the radius of the inner curb line.



Method No. 2. Where the curvature and width of street will not permit the use of method No. 1, the following method may be used. Nothing less than 3-inch bats shall be used, and in no case shall brick be broken longitudinally to make closure. Bats shall be placed at right angles to one of the courses, and the amount of space to be batted in shall by use of the successive courses not exceed a whole brick.



If method No. 1 cannot be used and method No. 2 is not desirable, the following method No. 3 is suggested.



Brick shall be laid as shown on plan and, except as noted, nothing less than ½ brick shall be used in making closures.

Hillside wire-cut lug shall be laid around curves in the same manner as on straight pavement, except that the courses will be curved and parallel to the curb lines.

Inspection. Immediately after laying, the brick surface shall be swept and inspected. Brick not laid with the best edge up shall be turned over and those not meeting the requirements for visual inspection shall be removed and replaced with perfect brick.

Joints. All joints must be kept clean and open until filled as specified.

XII. *Street Car Tracks*

See recommendations and specifications of Committee on Street Railway Pavements including track construction A.S.M.I.

XIII. *Expansion Joints*

Premolded. When cement-grout filler is used, a premolded expansion joint of bituminous material shall be placed parallel with and adjacent to the curb line or street-car track, around every obstruction in the surface of the street, and transversely across the street at points of change in grade or alinement as directed by the engineer and transversely across the street at the prolongation of the curb line at all intersecting streets.

Quality. Expansion joint shall be a bituminous material unaffected by the action of water or street liquids and shall be of such consistency that the penetration registered by a Roberts sharp No. 2 needle under a weight of 200 gm. for one (1) minute at a temperature of 32 degrees Fahr. shall be not less than twenty (20) and when penetrated by a No. 2 needle under 50 gm. for five (5) seconds at a temperature of 115 degrees Fahr. shall be not over 100.

Dimensions. Joint shall be not less than three-quarters (¾) inch in thickness and not less than depth of the brick in width.

Placing. Expansion joint shall be placed immediately prior to laying brick wearing surface. It shall be placed with ends of strips closely joined and so that when brick are rolled the top of joint shall be flush with the top of pavement.

XIV. *Rolling*

After brick in pavement have been passed for rolling and surface has been swept clean, pavement shall be rolled with a self-propelling tandem roller weighing approximately three (3) tons, in the following manner:

Brick next the curb shall be tamped with wooden tamper to the proper grade. Rolling shall then commence near the curb at a slow pace and continue longitudinally back and forth toward the center until the center of the street is reached; then passing to opposite curb it shall be repeated in the same manner to the center of the street. After this passing of roller the pace may be quickened and rolling continued until the brick pavement has a smooth surface. The pavement shall then be rolled obliquely from curb to curb, repeating the rolling in opposite oblique direction. After this rolling has taken place, all broken or injured brick must be taken up and replaced with perfect ones. The substitute brick must be brought to the true surface by tamping.

After final rolling pavement shall be tested with a ten (10)-foot straight edge, laid parallel with the curb, and any depression exceeding one-quarter (¼) of an inch must be taken out. If necessary pavement shall be again rolled.

XV. *Filler*

(A) *Cement Grout. Description.* Joints between the brick shall be filled with a portland-cement grout filler composed of one (1) part of portland cement and two (2) parts sand.

Water. Water shall be clean, free from oils, acids, alkalies or vegetable matter.

Cement. Portland cement for grout shall conform to the definition and meet the requirements of the Standard Specifications and Tests for Portland Cement of the A.S.T.M., serial designation C9–17 and all subsequent amendments and modifications thereto.

Sand. The sand shall be sharp, clean, free from loam, clay, organic matter or other impurities. All sand shall pass a No. 12 standard sieve and not less than 40 per cent. shall be retained on a No. 50 standard sieve and not more than six (6) per cent. shall pass a No. 100 standard sieve.

Where the location of the available sand is such that it is impracticable to obtain sand of the above grading, the engineer may direct the changing of the intermediate sieve and then vary the proportions of the cement and sand from the 1 to 2 mixture to such a proportion as will when used with the sand available give an equally strong grout.

Sprinkling. Immediately before applying grout the brick shall be thoroly wet by being gently sprayed with clean water.

Mechanical Mix. A mechanical mixer approved by the engineer should be used.

Cement and sand shall be thoroly machine mixed dry until the mass assumes a uniform color and enough clean water gradually added to obtain a grout that will penetrate to bottom of the brick without separation of the ingredients. From the time the water is applied until all is removed and floated into the joints of the pavement, mixture must be kept in constant motion.

Hand-Mix. A mixing box if used, should be carried on wheels. The box should be about four (4) feet eight (8) inches long, thirty (30) inches wide and fourteen (14) inches deep, resting on legs of different lengths so that one corner of box shall be about three (3) inches above pavement. The use of at least two (2) boxes is recommended. The grout should be removed from the box with scoop shovels.

Before any grouting is done, a sufficient amount of cement and dry sand to complete the work prepared for grouting at that time, but not to exceed two hours run, shall be thoroly mixed dry until the mass assumes a uniform color. If the sand is wet, then only so much sand and cement shall be mixed as can be placed in the pavement within 45 minutes from the time of the beginning of mixing.

From this mixture an amount not exceeding two (2) cubic feet shall be taken and placed in box and water gradually added until a mortar is made which will penetrate to the bottom of the brick, without separation of the ingredients. The entire amount of water shall not be added at one time; a plastic mortar shall first be made and thinned down gradually to the proper degree.

From the time the water is applied until it is all removed and floated into the joints of the pavement, the mixture must be kept in constant motion.

Applying. The prepared filler shall be delivered from the mixer to the roadway surface in such a manner that there shall be no separation of cement and sand in transit or in place, and only in such quantities as can be immediately swept into joints.

Filler shall be applied to brick in front of the sweepers who shall rapidly sweep it lengthwise of the brick into joints until joints are filled. After fill has subsided in the joints and before initial set develops a second application of a thicker grout shall be applied in a similar manner until joints are filled flush with the top of the brick.

After this application has had time to settle and before initial set takes place, pavement shall be finished to a smooth surface with a squeegee or wooden scraper having a rubber edge which shall be worked over brick at an angle with the joints, leaving all the joints completely filled as above specified before the close of the day's operations.

The grooves or beveled edges of hillside brick shall be cleaned out after the grout takes its initial set but while it is still soft. Pavement shall then be swept clean.

Metal Strips. The contractor shall provide metal strips one-sixteenth (1/16) of an inch in thickness, six (6) inches in depth, and three (3) feet in length, which shall be inserted in a transverse joint in the pavement before closing the grouting of each work interval in order that the grouting shall end in a vertical joint. The strips shall remain in place until the filler has developed its initial set and be removed before its final set shall have occurred.

At no time shall more than two hundred (200) linear feet of pavement be laid in advance of grouting, and grouting must follow the laying as closely as practicable. When a cement-sand bed is used, all brick laid shall be inspected and rolled before the close of that day's operations.

Protection. When completed, and filler has received its initial set, pavement shall be covered with at least one-half (½) an inch of sand or earth which shall be frequently sprinkled in warm weather.

Opening to Traffic. No travel shall be permitted on pavement for a period of at least ten (10) days after grouting, or longer, as engineer may require on account of weather conditions.

Ample barricades and watchmen shall be provided by contractor for the proper protection of the filler.

(B) *Asphalt. Description.* General. The asphalt filler shall be homogeneous, free from water and shall not foam when heated to 200 deg. C. (392 deg. F.). It shall meet the following requirements:

Physical & Chemical Properties. 1. Flash Point not less than 200 deg. C. (392 Deg. F.)

2. Melting point (ring and ball) 65 deg. C (149 deg. F.) to 100 deg. C (212 deg. F.)

3. Penetration at 25 deg. C (77 deg. F.) 100 g., 5 sec.* Penetration at 0 deg. C. (32 deg. F.) 200 g., 1 min., not less than 10.

4. Ductility at 25 deg. C. (77 deg. F.) not less than 3.

5. Loss at 163 deg. C (325 deg. F.), 5 hrs., not more than 3%.

6. Total bitumen (soluble in carbon disulphide) not less than 99%. (If other than residual asphalts are used not less than 60%.)

7. Per cent of total bitumen soluble in carbon tetrachloride, not less than 99%.

Methods of Testing. 1. Flash point, open cut, A.S.T.M. tentative standard method D-92-21T.

2. Melting point, A.S.T.M. standard test D-36-19.

3. Penetration, A.S.T.M. standard test D-5-21.

4. Ductility, A.S.T.M. tentative standard test, D-113-21T.

5. Volatilization test, A.S.T.M. standard test D-6-20.

6. Total bitumen soluble in carbon disulphide, U. S. Dept. of Agriculture, Bulletin No. 314, page 25.

7. Bitumen soluble in carbon tetrachloride, U. S. Dept. of Agriculture Bulletin No. 314, page 30.

Heating. Filler shall be heated to a temperature not exceeding 200 deg. C. (392 deg. F.). It shall be applied at a temperature of not less than 350 deg. F.

The heater shall be equipped with a thermometer capable of registering at all times temperature of filler.

Cleaning the Surface. Brick shall be clean and dry when filler is applied. Immediately before filling joints, surface of the brick shall be swept clean. All joints shall be filled and surface dressing applied on day of laying. Filler shall not be applied if brick are wet, nor if air temperatures are such that filler will not flow freely to bottom of joints.

Filling Joints (*Squeegee Method*). Filler shall be removed from bottom of heater and applied promptly to pavement before cooling. Filler shall be worked into joints by means of hot iron squeegees operated slowly backward and forward at an angle with joints. Squeegee irons shall be kept hot and filler shall be applied and squeegeed until joints remain full. As little as possible of the filler shall be left on the surface of brick.

**Note.* The exact penetration limits should be inserted by the engineer with a 10-point limit. It is suggested that for low-temperature conditions a penetration of from 40 to 50 be specified and for high-temperature conditions a penetration of from 30 to 40 be specified.

Filling Joints (*Pouring Method*). Asphalt shall be removed from bottom of heating kettle and applied promptly to the pavement before cooling. It shall be poured into all joints from a spouted can, or similar device, and pouring continued until all joints remain completely filled.

Surface Dressing. (To be used only when face of brick is wire-cut.) Immediately after joints are filled a thin coating of dry stone screenings, sand or slag shall be spread upon the surface of pavement. Top dressing shall be of such sizes that all will pass a No. 4 sieve. As soon as dressing is spread, surface of the pavement shall be rolled to bed dressing into asphalt coating.

Opening to Traffic. Brick roadway may be open to traffic immediately upon completion of surface dressing.

(C) *Coal-Tar Pitch.* It shall meet the following requirements:

Water..0.00%
Specific gravity at 25 deg. C. (77 deg. F)........1.23 to 1.33
Melting point (cube method in water) 46 deg. C. (115 deg. F.) to 57 deg. C. (135 deg. F.)
The melting point specified should have a range of not over 10 deg. F., within the above limits.
Distillation test:
Total distillate by weight, 0 deg. to 300 deg. C., not more than 10%
Residue, not less than....................................90%
Specific gravity of total distillate to 300 deg. C., taken at 25 deg. C. (77 deg. F.) not less than....................1.03
Melting point of residue from distillation test not more than 75 deg. C.
Free carbon....................................20 to 35%

Methods of Testing:

Specific gravity, A.S.T.M. tentative test D-70-20T.
Distillation, A.S.T.M. standard test D-20-18.
Melting point—A.S.T.M. standard test D-61-20.
Free carbon insoluble in benzole, A.S.T.M. standard test D-38-11.

Heating. Filler shall be heated to a temperature not less than 300 deg. F. nor more than 350 deg. It shall be applied at a temperature of not less than 300 deg. F. The heater shall be equipped with a thermometer capable of registering at all times temperature of filler.

Cleaning Surface. Immediately before filling joints surface of brick shall be swept clean.

Filling Joints. Tar filler shall be removed from the bottom of heating kettle and applied promptly to the pavement before cooling. It shall be poured into all joints from a spouted can or similar device, and pouring continued until all the joints are at least one-half (½) and not more than two-thirds (⅔) full. Dry sand passing a No. 12 sieve, heated to a temperature of not less than 300° F. and not more than 400° F., shall then be poured or swept into joints until they are completely filled.

Opening to Traffic. Brick roadway may be opened to traffic immediately upon completion of filling joints.

(D) *Sand. Description.* Joints between the brick shall be filled with dry clean sand of such sizes that all will pass a No. 1 standard mesh sieve.

Filling. Sand shall be spread upon the surface of roadway to a depth of not less than one-half (½) inch. It shall then be swept into joints, completely filling them to bottom. An excess of sand shall remain upon the surface of roadway.

Opening to Traffic. Immediately after joints are filled, roadway may be opened to traffic.

XVI. *Maintenance*

The period of guaranty shall be — years. During period of guaranty, whenever surface of pavement becomes uneven, holding water one-quarter (¼) of an inch or more in depth in a distance of four (4) feet or less, the brick shall be taken up and relaid to proper crown and grade, supplying whole brick where required.

Conditions for Release of Guaranty. Prior to the expiration of guaranty, any brick which may be found soft, unsound, broken or disintegrated shall be replaced with new brick.

Those which have worn one-quarter (¼) inch or more from the general surface of the pavement, as existing at this time and as defined by the line of a four (4)-foot straight edge, if otherwise serviceable, may be turned over; if not, they shall be removed and properly replaced with sound material.

The new brick and filler shall conform to requirements hereinbefore mentioned.

XVII. *Combinations—Proper Design. Note to Engineer*

In designing a brick pavement from the specifications herein provided, the following combinations of bed, brick and filler should be used. No mention of types or method of construction of foundations is provided in these specifications, but the following principles should be observed. When a rigid (concrete) base is used the brick wearing surface shall be either a rigid type with cement-grout filler or flexible type with asphalt, tar or sand filler. When a flexible (all other materials except concrete) base is used, then only a flexible type wearing surface shall be used.

In the rigid (cement grout) wearing surface the following portions of the specifications shall be used:

Par. 1. Brick, any type or size with lugs.
Par. 10. Bed, (B) cement-sand or (C) slag.
Par. 13. Expansion joints, premolded.
Par. 15. Filler, (A) cement grout.

In the flexible (asphalt squeegeed, asphalt poured, tar poured, or sand filler) wearing surface, the following portions of the specifications shall be used:

Asphalt filler squeegeed.

Par. 1. Brick, plain wire-cut with lugs.

Par. 10. Bed, (A) either sand or (C) slag.

Par. 15. Filler, (B) asphalt squeegeed.

Asphalt filler poured, tar filler poured, sand filler.

Par. 1. Brick, any size or type with lugs.

Par. 10. Bed, (A) either sand or (C) slag.

Par. 15. Filler, (B) asphalt poured, (C) tar pitch poured, (D) sand.

Hillside brick should be used on grade of six (6) per cent or over. If bituminous filler is used on hillside brick it shall be poured.

REPORT OF CANVASSING COMMITTEE ON LETTER BALLOT ON CHANGES IN SPECIFICATIONS

St. Petersburg, Fla., Feb. 15, 1922.

E. S. Rankin,
President American Society for Municipal Improvements,
Newark, N. J.

Dear Sir:

Your canvassing committee has counted the ballots received from the letter ballot on changes in specifications ordered by the 1921 Convention and has the following report to make:

33 envelopes containing ballots were received.

The total number of votes on the changes in Bituminous Concrete Paving Specifications was 28.

The vote in detail on each change was	For	Against
On thickness of base	26	2
On wearing surface	26	2
On mineral aggregate	26	2
On grading table	25	3
On dropping bitulithic	26	1

The total vote on changes in Specifications for Brick Paving was 32.

The vote on the specifications as a whole was 27 for and 3 against.

1 vote was for all the specifications except that it was against Secs. X, XIII, XVA and XVC.

1 did not vote on the specifications as a whole but voted against Secs. III, IV and XVB.

The total vote on the changes in specifications for Stone Block Paving was 27.

The vote on changes was

Sec. 6,	25 for, 2 against
Sec. 7,	26 for, 1 against
Sec. 10,	26 for, 1 against
Secs. 13, 14,	26 for, 1 against

The result is the adoption of all the changes and the revised specifications by a large majority.

Respectfully submitted,
E. C. Garvin,
Chas. C. Brown,
Canvassing Committee.

TWENTY-EIGHTH CONVENTION OF THE AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS.

BALTIMORE, MD., OCTOBER 25, 26, 27, 28, 1921

BUSINESS PROCEEDINGS

Tuesday Morning, October 25, 1921

The Convention was opened at nine a. m., President R. Keith Compton presiding.

PRESIDENT COMPTON: Gentlemen, the Twenty-Seventh Annual Convention of the American Society for Municipal Improvements is now in session. I have the very great pleasure to introduce to you His Honor, the Mayor of Baltimore, Mr. William F. Broening, who will deliver the Address of Welcome.

MAYOR WILLIAM F. BROENING: Mr. President, Delegates to the Twenty-Seventh Annual Convention of the American Society of Municipal Improvements: It is a real pleasure to greet you and to bid you welcome to our city. Personally, I don't know of any body of men more welcome at this time, whom we are more anxious to have in our midst and to see the things that we are doing than the representatives of this organization, interested as you are in those things that affect the welfare of municipalities.

The city that greets you today is a new city; a city born of adversity, which has received the baptism of fire, and, in its new birth, has taken on a rapid progress, now numbering 750,000 people, and if it continues at the same pace, within five years will have a population of more than a million.

It is the new city that greets you; a city that has profited by a great calamity. A city, which in the things it is doing, I am sure, will give you an object lesson and an inspiration, so that you may go back to your respective municipalities with new courage in the solution of those problems that are daily presented for your consideration.

It was in 1904 that Baltimore was visited by a great conflagration—then a population of less than 500,000. Inside of two days it laid waste and destroyed $125,000,000 worth of property. It destroyed the very business heart of the city. You are now meeting in what is known as the "Fire District," and the property that stood on this site was entirely destroyed. Upon those ashes was erected this modern hotel, one of the latest acquisitions to our city.

Before that time Baltimore had what was known as surface drainage. There was no sewerage system. It is true that here and there was a private sanitary system, owned by one person or another, and along the route of that system privileges were granted to different other individuals to tie in. Waste water from the other properties was drained down on the surface to the streams. Thruout the city we had wells and cesspools from which the accumulation would be carried away in carts, after being put in barrels. Baltimore had just arrived at a stage when it believed it could, and had determined to, build a sewerage system when this conflagration came along. Our people were depressed, but it was remarkable that before the fire was under control, and ere the sun had set on the second day of that conflagration, a new spirit was born in our people and they determined to profit by that great catastrophe, and rebuild a bigger and better city. The next morning witnessed a wonderful scene of progressiveness. Merchants, business men and all others who had their places destroyed, began doing business wherever they could find the opportunity. In the garret, cellar, in stables, wherever they could put a desk and a chair, they located to resume their business. All the people caught the spirit and without wearying you with details, suffice it to say that from that time until 1919, our people not only recouped the great loss of $125,000,000, but the city itself has expended in public improvements some $52,000,000. The old cobblestone streets have passed away. We have some few around the city, and they have purposely been kept so that you gentlemen might see the relics of the old city. But for this they would have been removed long ago. But the majority of these cobblestone streets have given way under the direction of the President of your Convention, who is Chairman of the Paving Commission.

Now a systematic method of laying the streets and putting down improved streets has taken the place of the old piecemeal paving.

Of this $52,000,000, $25,000,000 is represented in a modern, up-to-date sewerage system, recognized by experts as being one of the best systems in the country. It was only about six months ago that a delegation from one of the South American States inspected it, one of whom told me that the information from the experts thruout the country was to effect that Baltimore had the ideal system.

Then the city limits grew entirely too small. The area then consisted of 31 square miles. For years the people had been clamoring for the opportunity to take in additional territory, so that the industries and the city might expand in keeping with the progressive spirit of the people. In 1918, by legislative enactment, the city acquired 66 additional square miles, making a present area of 97 square miles.

With that added territory came added responsibilities. Much of that territory is unimproved and public improvements must be extended into this newly acquired section. We endeavored to meet that in an intelligent way by appointing a Commission to study these problems, and then to make recommendations as to the improvements necessary, how they were to be made and how they were to be financed. The committee stated in its report, Baltimore must do many things in this newly acquired territory; it must complete many of the unfinished improvements in the old city that were inaugurated some years ago, and which the city has been gradually engaged in completing. They recommended $26,000,000 for general improvements, in which were included the extensions of the sanitary system, the extension of the improved streets, the building of new school houses, fire engine and station houses.

While $26,000,000 is a lot of money, it is not so much when it is to be distributed among all these different improvements.

In the new territory before its acquisition by the city, there were some seven private water companies, and under the provisions of the act by which this additional area was acquired, it was impossible for the city to lay one foot of pipe in any territory operated by a private company without acquiring either by purchase or condemnation the rights of that company. That necessitated a survey and we had two very capable engineers—I notice one of them is here as a delegate to this convention—who made a survey of all these properties, their utility so far as could be coordinated with the municipal system; their value from a monetary standpoint, so that we might have the information when it came to taking them over. They were appraised at between five and six millions of dollars. We have already acquired three of them, one of which is the largest of all the seven. The Committee further stated that to acquire these properties and coordinate them in the development of the municipal system, to increase the supply and storage capacity; to put in settling reservoirs and additional filtration units, would cost $25,000,000.

Then along came another Commission, the Export and Import Board of Trade, recommending that this was the time for Baltimore to develop its harbor. Favored by nature with a wonderful harbor, miles and miles of water front, virgin in character so far as possibility of development is concerned, this Board suggested this was the time for the city to improve its port facilities and thus be prepared to garner a fair share of the commerce bound to move over the seas when the period of readjustment and reconstruction is completed. They recommended a bond issue of $50,000,000 for the development of our port, which was adopted. There was also a demand for a municipal hospital for infectious diseases, estimated to cost near a million dollars, which was included in the committee's report, making a total recommendation of $102,000,000 to be raised by public loans. We did not submit the entire $102,000,000, as we did not believe that the whole amount could be advantageously expended within the next few years, so we only submitted $52,000,000 of the $102,000,000.

The whole of the $26,000,000 loan for the improvements, paving of streets, sewers, school houses, etc., $15,000,000 of the $25,000,000 for the water system; the whole of the hospital recommendation, and $10,000,000 of the $50,000,000 loan for the development of our port were submitted, and in the face of loans failing of passage in many of the Western and Southern cities, we did not lose heart. The wonderful progressive spirit displayed by our people during all the years since 1904 was of such a character as to convince us that when they knew and understood, these loans would be ratified. We inaugurated a campaign of education, the people were informed of the city's needs, why it was necessary; what the future meant for Baltimore if these loans were approved and what would happen if they were not. Suffice it to say that in a presidential year when public attention was riveted upon the presidential candidates and upon those great issues then confronting the American people, an unprecedented vote of some 170,000 was registered for these loans, while in opposition only a negligible vote of some 6000, which was the highest cast against any one of the four propositions. I mention this so you might know and understand how the great majority of our people sensed the real situation and fully appreciated what had to be done to promote the growth of municipality, so that it might be known among the other municipalities of the country as a progressive city. Those loans were approved last November. The Enabling Act passed for the submission to the people, provided for the appointment of two commissions, one to consider the harbor development and activities dealing exclusively with the development of the port; the other assuming charge of the general improvements and the development of the water system. These commissions came into being immediately after last November's election, and since that time they have been continuously at work with quite a program already mapped out.

We probably have more miles of street now being improved than ever in the history of the city. Baltimore probably has more paved streets, for its area, than any other city of like area in the country.

We are now building a dam at Loch Raven. It is to be raised to a height of 240 feet. We have had some litigation in connection with this work, but we believe we are happily over that. The contract provided that the contractor should have the dam raised to a height of 204 feet by the 15th of November, so that we could have the advantage of the fall rains for storage purposes. The dam has been constructed in excess of this height, but because of litigation instituted to prevent the flooding of the roadbeds by the damming of the water, openings had to be left so as to keep the water at the former level of the dam. This new construction is serving no useful purpose now, and will not until we adjust our differences with those in that section, which it is hoped may shortly be done. It is a wonderful piece of engineering work, well worth a visit while you are in the city.

You will be taken over the streets and the sewerage system, to both of which we are adding, and improvements well worth seeing.

On the harbor proposition we have the report of two well-known engineers of the country, who were employed to study our port facilities, with a view to greater development. This was submitted a month ago to the Port Commission and that commission is now considering the recommendations therein, for the building of modern piers, docks and warehouses, which, when completed, will make the Port of Baltimore second to none in the country. I understand a trip has been arranged during your stay, to view the water front. We desire you to see the harbor and those wonderful possibilities of our port, of which mention has been made.

I could tell you of other activities, to say nothing of the schools we are building—more schools in two years than were built in the last 12 years. We have completed three this year, representing a total cost of more than a million and a half dollars. The architect has just submitted his plans for another, for which bids have been advertised, representing a cost of half a million. We have a program of ten other schools in connection with which we have arranged a plan that is quite unique in the history of municipal building. We first appointed architects for the various buildings and then constituted those architects an Advisory Board. We have had them to sit in and confer with each other and with the Chief Engineer and other technical men of the Administration, for the purpose of making for standardization, eliminating non-essentials and assuring an economical building of all the structures. It is working splendidly. We are receiving under this plan intelligent thought and intelligent action and the benefit of the varied experience of these men, the best architects in our community. In addition to the buildings mentioned, our program provides for ten other buildings, among them a senior and junior high school; four junior high schools; a colored senior and junior high school and five elementary schools. We are giving a great deal of attention to vocational study and vocational training. We desire you to see some of these school houses and other improvements, after which we would appreciate the benefit of your judgment and your thought.

It is for that reason that we are so glad to welcome you here, knowing as we do that men engaged, as you are, in helping to solve the problems daily presented in your respective municipalities; men engaged day after day in doing those things that are so vital and so essential to the peace, happiness and the well-being of your respective communities, are bound to bring with you a judgment ripened with many years of experience; a judgment that surely is going to be helpful, not only in the deliberations of this convention, but as a valuable contribution in the consideration of like problems throughout the country.

Another thought and I am done. It relates to the unemployment problem in the solution of which our whole country is interested. It is to be of service to the unemployed and to help tide over this depression in such manner as will enable men and women to eke out an existence without losing their self-respect. For the consideration of this problem the conference was called by President Harding at Washington. We sensed this condition early this year, for on the 6th day of last February, we inaugurated what was known as a Municipal Emergency Bureau, having for its purpose the helping of the unemployed and the serving of the employer. There is nothing more depressing than men and women wandering around the city out of work, looking for employment. The first step was to organize the unemployed; to take these wandering men and women and concentrate them at one particular place, and put them in touch with the medium thru which they might connect with some position. We then called a conference of the heads of our various departments, especially those engaged in the public improvements. We had them anticipate their program for the year, and while not the proper time to begin public improvements, with the frost still in the ground, we managed to initiate the work in a manner that enabled us to take care of the great majority of the unemployed. Then the Bureau got in touch with all the private industries thruout the community and with the cooperation of these activities we managed to take care of a great many more, so that we reduced to a minimum the unemployed situation in our community, preventing the establishing of a single bread line or soup house. There was very little money spent here for the purpose of direct charity as compared with the great amount of money expended thruout the country.

Now there is a proposition here that I want you to give some thought to, not necessarily in your convention, but to carry back home with you. For many years I have been convinced that public improvements of the municipality, of the state, and of the nation ought to be divided into two classes; one called the emergency public improvement and the other the necessary public improvement. The necessary things that you gentlemen are engaged in day after day, that must meet the ordinary needs of the community; the others not immediately necessary, but an improvement which as time goes on will enhance the welfare of the community, will be of some value, such as beautifying the approaches of the city, and similar construction having no value at the immediate moment. They are not imperative, but as time goes on they will have a value, and it ought to be an improvement that can be worked at today, left off tomorrow, resumed again next week. For what purpose? As the safety valve takes care of the surplus steam in the boiler, so the emergency improvement will take care of the surplus unemployed in the community.

When men are out of work there should be some place in the community where they could get a job to earn enough to keep body and soul together, and to take care of those who are dependent upon them, without forcing them to appeal for public charity. That was a thought that came to me, some years ago when I was prosecuting officer of the city. Men were prosecuted for failure to support their dependents. They claimed work could not be had. We had no means of ascertaining whether this was true or not, and surely it was manifestly unjust to punish any man unless we were certain that the opportunity for employment was open and he refused to accept it. So the thought came that there should be some place where such men could be sent, where they could get something to do that would enable them in part at least, to meet their responsibilities.

The improvements should be divided into two classes, necessary and emergency, and there ought to be a difference in the wage. First, the incentive for better employment must not be destroyed. When a man is given emergency work, you don't want him to be satisfied with it. He is to understand it is a temporary arrangement. He is to stay there until the door of opportunity opens elsewhere, and when it does, you want him to accept it. This he will do if the other place means additional pay to the extent of 20 to 25% for the same time and effort exacted of him in his emergency employment. Thus is the emergency work reserved to absorb the surplus labor for which there is no other opportunity.

Now, as the taxpayer is made to bear this burden of emergency employment for improvements not necessary, that burden should be made as light as possible to accomplish the purpose in mind in thus meeting the emergency. It was along this line that we inaugurated our improvements in connection with the opening of our municipal bureau, and while our arrangement was not exactly ideal, it accomplished in part what we had in mind. We classified certain of our improvements as emergency. With the market wage for labor between 35 and 45 cents per hour, we paid on this emergency work 30 cents an hour. We knew that every man who was willing to take this work at that wage was in need of employment and not leaving any other position. Had we paid the market wage, we would have been in competition with every employer of labor and we would at once have brought in competition for this work, men seeking a change of position with those in absolute need. This could not be avoided without special investigation, which would have taken time and money. It assured us that every man who was willing to accept such employment was in need of work and it was for those that the opportunity for such employment was created. It also assured against unemployed from other parts of the country flocking to Baltimore, as the pay was not sufficiently attractive to justify the taking of the chance. The amount, however, was sufficient to maintain existence of those employed without the acceptance of charity, and in a manner that meant the maintenance of self-respect. Those with dependents were always given the preference.

Another reason for not paying for this class of work the market wage was that those we were seeking to serve were not accustomed to such work, and we were not seeking workers which entitled the picking of those wanted, but merely creating opportunity to those who were willing to undertake what we had to offer, and the great majority of those who applied had not been accustomed to such work and were unable to compete with men whose regular employment was of this character. We found by comparison that the same number of men at 45 cents an hour, produced the same construction at less cost than those at 30 cents an hour. We expected this. All we wanted was an honest effort to give something in return for what we were giving them, and as long as they made this honest effort, no matter what was produced, we kept them on, and where we found a man was efficient in that particular line, he was transferred to what we termed the regular roll, receiving market wage.

Because of this difference in wage, the system was criticized, but it served a good purpose. It aided in tiding over a very distressing situation. We have continued our Bureau. We have made it more efficient. We have added to it and we are speeding up as much as we can the activities of the Bureau, so that we can be of greater service to the unemployed. I leave this thought with you, so that you men, as you go back to your homes, may give consideration to the plan, with the view of bringing about the creation of some such system in every city and state thruout the country, thru which the unemployment problem may be solved by the absorbing of the surplus labor in every community.

I have already talked to you longer than I had intended. I have touched on a subject that it was not my intention to speak of, and yet I felt inspired in looking over this audience and recognizing that you are the men that the executive heads of your communities must largely lean upon. I am indeed glad to welcome you here. I hope your stay will not only be profitable, but likewise thoroly enjoyable, so that when you leave, it shall be with such delightful recollections as will create a desire to again come back and break bread with us.

In this spirit we bid you welcome. The city is yours. What you want of those things you see, just tell Colonel Compton and if he can't send them to you, let me know. If you can't carry them away, we will send them by express or freight. We will suit your convenience and endeavor to meet your desires.

PRESIDENT COMPTON: Now, ladies and gentlemen, we want you to meet the man who has handled this Convention in the city, as the Chairman of the Local Committee, who has provided for all the entertainment and who will in a few words tell you just what has been done. I therefore have the pleasure of introducing Major Whitman, the Chairman of the Convention Committee.

MAJOR WHITMAN: Mr. President, Members and Guests of the Society: I am not going to take up your time in making a speech, because there are many more important matters to be discussed by the Society. I simply want to make an acknowledgment here of the work that has been done by our Committee. I have done very little. I had the good judgment to pick workers on the Committee and the Committee has worked hard and long and I know they are all delighted to see you here. I want particularly to acknowledge the work that has been done by our Assistant Chairman, who really did the work that I should have done, Mr. Requardt, and then, in spite of the hard times, the Chairman of our Exhibit Committee had no difficulty whatever in disposing of the exhibit space, and not only did he dispose of it, but we have the money, which is more.

Major Whitman announced all entertainments to be given and extended an invitation from the local Chapter of the American Society of Civil Engineers to out-of-town members.

PRESIDENT COMPTON: It is not necessary for me to introduce the next speaker. You all know him. I have the pleasure of presenting the First Vice President, Mr. Rankin, who will deliver the Response to the Address of Welcome.

MR. RANKIN: Mr. President, Mayor Broening, and Gentlemen of the Society: It is one of the unwritten rules of this Society that the Address of Welcome is made by the Mayor of the city in which the convention is held and is responded to by the first Vice President of the Society. This very pleasant custom has one unfortunate feature; on the one hand is the Mayor, a man who by the very nature of his office is accustomed to public speaking on all occasions and on all subjects, and on the other an engineer, and you know as a class we are the most modest of men and proverbially deficient in this respect, so much so that one of the accepted definitions of an engineer is that he is a man who knows how to do things, but does not know how to talk about them.

There is a story told of a banquet given to celebrate the opening of one of the great railroad bridges of the country. The engineer, the man who had designed and erected this great structure was called on for a speech. He arose slowly to his feet, hesitated a minute, and said "Gentlemen, you will have to excuse me. I am an engineer. I can build a bridge but I can't make a speech."

And so I feel that you have the advantage of me for you have not only made a most graceful speech but you have built a bridge, a bridge that stretches from this great city of yours to the four corners of the country, and even across the border to that green oasis of Canada on the north, a bridge whose foundations are hospitality, whose superstructure is cordiality and whose roadway we have paved with golden words of welcome. Over this bridge have come these delegates to see this great city of yours. They want to learn how you do things here. They want to see how you are going to spend that $126,000,000. We are the greatest little spenders you ever saw. We will spend all the money you appropriate for us and then ask for more.

We deeply appreciate, Mr. Mayor, the cordial manner in which you have extended to us the freedom of your city, and yet it is really no more than we expected of you when we accepted your invitation, because in doing so you are simply carrying out the traditions which have been handed down to you from the very beginnings of this Commonwealth, for Maryland was the first of the American Colonies to freely throw open her doors to all without regard to race party or creed. We also appreciate the lavish series of entertainment you have provided for us and we are sure we are going to enjoy them. Primarily, however, we are here for another purpose. We are here on business. We want to see your great sewage disposal plant; we want to ride over your smooth pavements; we want to see your parks, your lighting system and your water supply. We also cherish another hope, and that is, that this obligation may not be entirely one-sided. I remember very distinctly my last visit to Baltimore. I had stopped over here for a day, twelve years ago, on my return from one of these same Conventions, to call on my old friend Howard Bryant, now the President of your Second Council. I am sorry he is not here today for if he were I am sure he would agree with me when I say that when I left we had both gained from the visit for he introduced me to your famous Baltimore oysters and I introduced him to your own sewage disposal plant, then in course of construction, but which he had never before visited. And so we hope it may be on this occasion, that not only may we taste of your hospitality, not only may we eat of those famous oysters and drink of your pure water, unless I correctly interpreted the remarks that you made a few minutes ago and you have something better to offer us, and not only may we listen to the soft music of the wheels rolling over your smooth pavements, and smell the perfumes, or perhaps I had better say, fail to smell the perfumes distilled from your disposal works, but that we may also leave with you some few thoughts which may be of benefit to your city, so that when we go Baltimore may feel that she has profited by our having been here.

Mr. Mayor, on behalf of the American Society for Municipal Improvements I thank you for your cordial welcome.

PRESIDENT'S ADDRESS

Col. R. Keith Compton, Baltimore, Md.

It is incumbent upon your President to perform such duties as pertain to his office, and it is the usual custom for him to deliver an address at the Annual Convention, giving in a brief manner the status of the Society, together with a short outline of its work during the year, and such recommendations as will, in his judgment, advance the interests of the Society and the public which it serves. It is not your President's intention to deliver a long address; but he will endeavor to cover, in a brief manner, such points as will meet the occasion in a practical way.

The Report of the Secretary and that of the Treasurer will go very much into detail and will give you the standing of the Society, both as to membership and as to finances. Your President will deal, therefore, more particularly with a few points which he hopes will tend to emphasize the usefulness of a society which has been in existence for twenty-seven years and for that period has a continuous record of service to the public represented by its members.

The Secretary reported our membership as of September 30, 1920, as 611. Taking our admissions and losses during the year, our membership, as of September 30, 1921, is 648, or an increase of about six per cent. It would appear that our loss in membership is heavy, and this is accounted for by deaths, resignations, severance of business and official connections, and possibly some of our members have resigned owing to our increase in annual dues, recommended by the Executive Committee at St. Louis in 1920, and authorized by vote of the Society.

The increase in dues was absolutely necessary in order to avoid a serious deficit in the Society's finances. Our present dues, even as increased, are moderate, and any member is well repaid when he takes into consideration the immense benefits which accrue from membership in the Society. Our Proceedings are books of reference containing reports and specifications on every phase of municipal activities, and they constitute an important addition to the library of any engineer or municipal official.

Under a recent revision of our By-laws, we now have eleven General Committees, of which there are fourteen Sub-Committees in various capacities. In addition, there are eleven specifications Committees and three Special Committees. To provide for a full personnel on these committees means approximately 150 appointments.

I am sure that all of you gentlemen will agree that the success of this Society depends largely on committee work. That work must be energetic, active, prompt and thoro. To secure the proper men for these committees and at the same time hold on each committee experienced men of a previous administration is an immense job. In order that committee work may be more extensive and thoro in its scope, it is urged that each committee hold during the year at least one session several months prior to the convention, in order to outline its work; and indeed, it is felt that your Executive Committee should hold at least one meeting during the year in order that your President may have the advice and guidance of that committee in the management of the affairs of the Society.

You will see from the report of the Treasurer that the financial condition of the Society is gradually improving, so that the deficit with which we started on the first of the year is now being steadily reduced. This condition is satisfactory and, together with our increase in membership, tho small, indicates a healthy, progressive condition of the Society. When the increase in dues was decided upon, it was thought that this increase might be necessary for a year or so only, or until such time as conditions all over the country assume a more normal shape, and that within a year or so we might reduce our dues to the amount originally fixed. This matter must, of course, be left to the judgment of the Executive Committee; but as the matter now stands, we can very safely depend on a steady increase in membership, and therefore a steady increase in revenue, putting us in a safer position from year to year.

Now, as to extending the scope of the Society. This is an open question, and there is a great deal to be said on both sides. There are some of us who feel disposed to hold the Society at about its present size, feeling that to extend its scope might make the Society more difficult to handle, and therefore weaken our present good work. On the other hand, there are those of us who recognize the good work of the Society, but feel that we have not made our work known to the public, and known to those high city officials who, after all, are the ones who receive the benefit of this work. It would appear, therefore, that we should make ourselves better known to the public, and this can only be done by advertising the work of the Society, thru team-work on the part of the committees, and up-to-date reports and publications of proceedings which can be used as a reference at any time.

The following paragraph from a periodical suggests the interest that can be developed.

"From the 24th to the 28th of this month, there will gather in Baltimore men of standing in communities scattered all over the United States and Canada. These men represent the doers and the thinkers of the world; they plan and build cities; they make pleasant places in which to live; they provide fields for the sowing and reaping of industrial dollars; they make for the advancement of civilization. These men are not poets nor are they of the class which raves against the established order of things. Far from it. You will find them hard-headed business men, men who balance facts for the profit to be gained. If a city district will become more valuable by having a street opened to it, they are the men who can see that fact and who can raise the money and push the project thru.

"These men are city builders. They are members of the American Society for Municipal Improvements, which meets in Baltimore for its 27th Annual Convention."

From time to time, an effort has been made to hold, in connection with our conventions, a conference of Mayors, with varying degrees of success. Such city officials must be vitally interested in our work, and might it not be well to work out some plan whereby such a conference can become a permanency and a section of this Society, which can meet at the same time and in the same city with us, having some sessions separate and distinct from us and other sessions in connection with us; some plan under which they can consider themselves members of this Society and entitled to all the benefits of our work and to have a voice in the conduct of this Society, giving us at the same time the benefit of their good judgment and advice.

Another point wherein this Society can be of immense benefit and influence in this country at this time is in connection with the unemployment situation. It is estimated that there are from 3,500,000 to 4,000,000 unemployed in this country alone. With the winter season approaching and with at least fifty per cent. of our public works in those localities where climatic conditions make it impossible to continue them, we must view the immediate situation with concern and alarm. There has been no organized effort on the part of the engineers of this country to promote construction activity, but it must be admitted that a revival of such activity would greatly assist in relieving the situation.

A recent questionnaire sent out by the Engineering News-Record elicited varying replies. Some engineers are in favor of letting next year's contracts this fall. Others, for very good reasons, are in favor of holding them until later in the winter or spring.

We should not allow ourselves, however, to be misled with the idea that the awarding of contracts this fall for work to be done next spring, or the execution of public works during the winter, even if climatic conditions are favorable, will entirely relieve the situation. In some localities, the excessive cost would make this procedure prohibitive. Then again, a contractor bidding our work late in the fall, with the prospect of his work being carried over until spring, will figure the cost of materials as they are at the time he files his bid. He has no assurance that materials will be lower in the spring. In localities, however, where mild winters prevail, contracts may be awarded and the work proceeded with during the winter months without serious interruptions.

It would appear that the better way to approach this subject would be to bring into consultation all concerned, the producer, the material man, the dealer, the contractor and the engineer. It is up to the producer to figure his production with a reasonable profit. It is up to the dealer, the material man, and to the contractor to do the same, and thereby come before the public with a reasonable proposition and relieve the already overburdened taxpayer, who in some instances, is now paying for public works double what he paid prior to the war. No one would claim that we can or should go back to prices or conditions as they prevailed prior to the war; but we must approach the subject with the idea that we should and must go back to reasonable conditions. This can only be done by all interests working in harmony, with full co-operation and co-ordination.

What is really needed is for the engineers, those who are responsible for the expenditures of public money, to take the leadership in this matter, and it is generally conceded that the advice of the man who assumes this responsibility will be followed, provided he is intelligent, aggressive, forceful and public-spirited.

The question is: What can engineering and affiliated societies do to assist in the unemployment situation in this country? It is hoped that before this convention adjourns a committee will be appointed to study this situation and to advise your membership who are in charge of public works in the various sections of the country what can best be done under the circumstances.

REPORT OF THE EXECUTIVE COMMITTEE

Aside from reference of resolutions to the committee or resolutions and the discussions of the reports of the Secretary and Treasurer and reference thereof to the Financial Committee action was taken upon changes in membership as follows:

CHANGES IN MEMBERSHIP

NEW MEMBERS

ACTIVE

Geo. W. Andress	Newark, N. J.
James W. Armstrong	Baltimore, Md.
Boyd A. Bennett	Lynchburg, Va.
N. Adelbert Brown	Rochester, N. Y.
Thomas H. Curtis	Fairmont, Minn.
Jos. E. English	Trenton, N. J.
C. J. Hellen	Baltimore, Md.
S. G. Highland	Clarksburg, W. Va.
Woolsey F. Jones	Birmingham, Ala.
John Klorer	New Orleans, La.
A. A. Krieger	Louisville, Ky.
H. E. Miller	Raleigh, N. C.
Lyons Mussina	Williamsport, Pa.
J. Franklin Perrine	Long Island City, N. Y.
S. John Scacciaferro	Clifton, N. J.
Fred H. Shepheard	Long Island City, N. Y.
Henry G. Shirley	Towson, Md.

V. Bernard Siems	Baltimore, Md.
John F. Skinner	Rochester, N. Y.
W. A. Vaughn	Evansville, Wis.
N. T. Veatch	Kansas City, Mo.
Russell S. Wise	Passaic, N. J.
Abel Wolman	Baltimore, Md.

AFFILIATED

Nebraska Legislative Bureau, Edna D. Bullock, Rep.	Lincoln, Neb.
Sheppard T. Powell	Baltimore, Md.

ASSOCIATE

Fred C. Campbell	Chicago, Ill.
Edward L. Flannigan	Baltimore, Md.
Inland Engineering Corporation Robert W. Haff, Rep.	New York City
Theodore R. Kendall	New York City
Geo. C. D. Lenth	Chicago, Ill.
Modern City Publishing Co., H. E. Burrows, Rep.	Baltimore, Md.
W. E. Rosengarten	New York City
Tomkins Cove Stone Co., Harry T. Clews, Rep.	New York City
Westport Paving Brick Co., John W. Hall, Rep.	Westport, Baltimore, Md.

TRANSFER FROM ASSOCIATE TO ACTIVE

Herbert E. Fletcher	W. Chelmsford, Mass.
Walter Buehler	New York City

LOSSES IN MEMBERSHIP

RESIGNATIONS

Active

Joseph I. Bingham	Elmira, N. Y.
C. S. Butts	St. Louis, Mo.
A. W. Dean	Winchester, Mass.
P. W. Henry	New York City
Harold R. Holmes	Lockport, N. Y.
J. N. McKelvey	St. Louis, Mo.
Henry N. Ogden	Ithaca, N. Y.
S. G. Pollard	Cincinnati, O.
C. M. Talbert	St. Louis, Mo.

Affiliated

Clarence W. Brazer	New York City
J. T. Dodds	St. Louis, Mo.
R. O. Schaefer	Little Rock, Ark.
D. C. Sowers	Akron, O.
F. E. Turin	St. Louis, Mo.

Representative Not Reappointed

A. E. Sheldon	Lincoln, Neb.

DROPPED FOR NON-PAYMENT

Active

Allen, F. R	Little Rock, Ark.
Barnes, J. H	St. Joseph, Mo.
Crowley, J. W	Davenport, Iowa
Dubuc, J. H	Montreal, Que.
Duchastel, J. A	Ontremont, Que.
Edgerly, R. J	Albany, Ga.
Laberge, F. C	Montreal, Que.
Linsley, C. W	Oswego, N. Y.
Russell, G. R	Rosendale, Kan.
J. P. Vincent	Hutchinson, Kans.
C. D. Weirbach	Allentown, Pa.

Affiliated

R. D. French	Montreal, Que.

A vote of thanks to the St. Louis members for payment of $800 into the Treasury of the Society under the terms stated in the report of the Secretary.

A number of invitations from cities for the 1922 Convention were referred to the incoming Committee on Place of Meeting.

REPORT OF THE SECRETARY

Charles Carroll Brown, St. Petersburg, Fla.

The Secretary presents his report for the year ending October 1, 1921.

The following table gives the record of changes in membership for the year beginning October 1, 1920, and ending October 1, 1921:

Class	Membership Sept. 30, 1920	Admitted During Year	Lost During Year	Membership Sept. 30, 1921
Active	457	106	30	483
Affiliated	24	15	4	35
Associate	130	30	30	130
Totals	611	151	114	648

Following are the changes in personnel since the publication of the lists on pp. 307, 310 and 459 of the Proceedings for 1920:

NEW MEMBERS

Active

Anthony, Harvey M.	Muncie, Indiana
Christhilf, A. E.	Baltimore, Md.
Emmart, Wm. W.	Baltimore, Md.
Finck, Geo. E.	Baltimore, Md.
Goob, Chas. F.	Baltimore, Md.
Grinnalds, Jefferson C.	Baltimore, Md.
Kehler, S. I.	Baltimore, Md.
Megraw, Wm. A.	Baltimore, Md.
Perring, H. G.	Baltimore, Md.
Requardt, Gustav J.	Baltimore, Md.

Shirley, Joseph W.	Baltimore, Md.
Smith, Nathan L.	Baltimore, Md.
Whitman, Ezra B.	Baltimore, Md.

Affiliated

Hebden, Edwin K.	Baltimore, Md.
Proctor, Ralph F.	Baltimore, Md.
Sucro, Wm. G.	Baltimore, Md.
Wysor, W. W.	Baltimore, Md.

Associate

Christhilf, S. M.	Baltimore, Md.
West, L. B.	Kinston, N. C.

REINSTATED

Active

Flood, Walter H.	Chicago, Illinois
Newton, S. D.	Cleveland, Tenn.

RESIGNATIONS

Active

Harting, O. F.	St. Louis, Missouri
Toensfeldt, Kurt	St. Louis, Missouri

Affiliated

Hidden, Edward	St. Louis, Missouri

DECEASED

Active

Gillespie, Richard H.	Allentown, Pa.
Owen, James	Orlando, Florida

Associate

Tefft, G. H.	Chicago and Pittsburg
Ware, James T.	Kansas City, Mo.

REPRESENTATIVES OF ASSOCIATE MEMBERS NOT REAPPOINTED

Johnson, A. N.	College Park, Md.
Sheidler, P. K.	Cleveland, Ohio
Howland, W. H.	Newark, N. J.
Alley, H. L.	Boston, Mass.
Donelson, J. E.	Birmingham, Ala.
Head, J. H.	Boston, Mass.
Horn, J. M.	Wilmington, Dela.
Turner, R. W.	New York City, N. Y.

MAIL RETURNED UNDELIVERED

Active

Erwin, M. C.	San Antonio, Texas
Firth, Joseph	W. Palm Beach, Fla.
Hardy, William G.	Montreal, Quebec
Willis, T. L.	New Orleans, La.

Affiliated

Shakman, J. G.	Chicago, Illinois

The following table shows the monthly receipts during the year, classified as to source, and the monthly remittances to the Treasurer:

Month	Membership Dues			Proc. Sold	Spec. Sold	Advts.	Misc.	Remitted to Treas.	Date
	Active	Affil.	Assoc.						
1920 Oct.-Nov...	$647.50	$25.00	$235.00	$12.00	$13.25	$39.50	....	$972.25	12–1–20
1920–21 Dec.-Jan...	577.25	30.00	285.00	33.00	.25	....	$1.50	927.00	2–4–21
1921 Feb........	176.00	15.00	75.00	20.00	....	....	800.00	1086.00	2–28–21
March.....	125.25	....	65.00	5.00	1.25	....	200.00	396.50	3–31–21
April......	50.00	....	40.00	33.00	.25	....	....	123.25	4–28–21
May-June..	225.00	10.00	155.00	31.47	....	....	....	421.47	7–4–21
Jul.-Aug....	272.50	90.00	15.00	77.00	4.01	486.27	....	944.78	8–30–21
Sept.-Oct...	311.25	72.50	62.50	90.00	....	92.50	56.00	684.75	10–1–21
Totals....	2384.75	242.50	932.50	301.47	19.01	618.27	1057.50	5556.00	

To reconcile the above account with the Treasurer's account of receipts there should be added the Society's check for $49.13 transferring the cash balance in Ex-Treasurer Cellarius' account to present Treasurer Smith's account and $97.77 interest on Liberty Bonds and bank interest collected by Treasurer Smith, making a total of receipts for the year of $5702.90.

It will be noted that the receipts are nearly $1800.00 more than those for the preceding year. Much of this is accounted for by the payment to the treasury of the Society of $800.00 by the local committee of the St. Louis Convention, which shows in the February, 1921, account. About $500.00 comes from dues for 1922 advanced by active and affiliated members on the suggestion of the secretary in an effort to wipe out the deficit of past years as nearly as possible. The item of $56.00 on the last line in the miscellaneous column is mainly contributions from authors of papers to pay for the cuts used as illustrations, for the same laudable purpose. The miscellaneous item of $200.00 for March is apparent, not real, as it is only a rebate from the printer on account of error in computing and paying the amount due on his bill. The result of all these contributions has been to reduce the deficit on bills due up to October 1, 1921, to $500.00 as compared with $1630.00 reported last year. The increase in dues for 1922 is expected to make up for the advance payments made this year and it is confidently expected that the deficit will be entirely wiped out by the end of 1923 fiscal year.

The Executive Committee has voted to use the interest on the $800.00 paid in by the St. Louis Committee, to pay the dues of five municipal delegates representing the City of St. Louis, the following being the resolution adopted:

> *Be It Resolved:* That five paid-up memberships in perpetuity be established for municipal engineers in St. Louis, nominations of holders of such memberships to be made each year by the member or members of the Executive Committee of the Society resident in St. Louis, or, in case there are no such members, by the President of the Board of Public Service of the city of St. Louis.

The vouchers for expenditures and checks drawn therefor are listed by the Treasurer in his report. The items under these totals have been classified by the Secretary and show the following classified expenditures:

Office & Miscellaneous:		
Printing & Stationery	$192.60	
Telegrams & Exchange	20.92	
Postage, Express & Freight	174.92	
Office Supplies	7.85	
Clerical	600.00	
Refund of Dues	5.00	
A. S. T. M. Dues	15.00	1016.29
Convention Expense:		401.31
Proceedings:		
1919	1339.50	
1920	1757.00	3096.50

Letter Ballot:		121.25
Secretary's Salary:		
1920	300.00	
1921	300.00	600.00
Committee Expense:		78.00
Clearing House Expense:		5.00
Total		$5318.35
Over payment of $200 to printer, later returned, balances the account of payments at		5518.35

The increase in expenditures over the preceding year is mainly due to paying the debts of previous years, as shown by the items in the above table, made possible by the special receipts noted above. The general expenses of the Society were practically the same as last year, the distribution in items being somewhat different. An additional expense was the $121.25 for the letter ballot, the first one sent out.

The only indebtedness of the Society due at the date of this report was $500.80 due the printer on the bill for the 1920 Proceedings. If the membership remains the same, or increases as it seems to be continuing to do, we shall be able to meet the whole deficit during the coming year, with the increased dues.

REPORT OF THE TREASURER

Herman H. Smith, New York City

1920	*No.*	*Disbursements*	
Nov. 30	172	Geo. Banta Publishing Co.	$157.13
"	173	Wade & Wise Co.	29.25
"	174	Expert Reporting Co.	100.25
"	175	Chas. C. Brown	55.50
"	176	Chas. C. Brown	121.83
"	177	Franklin Press	500.00
1921			
Jan. 31	178	Geo. Banta Publishing Co.	121.25
"	179	Wade & Wise Co.	116.85
"	180	Franklin Press	230.00
"	181	Chas. C. Brown	300.00
"	182	Chas. C. Brown	134.48
Feb. 28	183	U. S. Photo Engraving Co.	171.15
"	184	Franklin Press	800.00
"	185	Chas. C. Brown	50.00
Mar. 31	186	U. S. Photo Engraving Co.	107.37
"	187	Chas. C. Brown	88.43
"	188	Chas. C. Brown	66.61
"	189	Wade & Wise Co.	2.25
"	190	Franklin Press	9.50
Apr. 29	191	G. R. Tuska	5.00
"	192	Wade & Wise Co.	7.50
"	193	Chas. C. Brown	55.89
June 30	194	Wade & Wise Co.	5.00
"	195	U. S. Photo Engraving Co.	4.12
"	196	Chas. C. Brown	117.88
Aug. 31	197	Wade & Wise Co.	95.75
"	198	Geo. Banta Publishing Co.	900.00
"	199	Chas. C. Brown	300.00
"	200	Chas. C. Brown	173.33

Oct. 1	201	St. Petersburg Times	$19.00	
"	202	Geo. Banta Publishing Co	574.36	
"	203	Chas. C. Brown	97.04	
"	204	Herman H. Smith, Treasurer	1.63	
		Total Disbursements		$5518.35

Receipts

(1920)	Cash on Hand	49.13	
Dec. 3	Chas. C. Brown, Sec	972.25	
Dec. 31	Bank Interest	.77	
(1921)			
Feb. 7	Chas. C. Brown, Sec	927.00	
Feb. 17	6 mo. interest Liberty Bonds, due 9-15-20	31.88	
March. 3	C. C. Brown, Sec	1086.00	
March. 15	6 mo. interest Liberty Bonds, due 3-15-21	31.87	
April. 5	Chas. C. Brown, Sec	396.50	
May 4	Chas C. Brown, Sec	123.25	
July 1	Bank Interest	1.37	
July 11	Chas. C. Brown, Sec	421.47	
Sept. 6	Chas. C Brown, Sec	944.78	
Oct. 11	Chas. C. Brown, Sec	684.75	
Oct. 19	6 mo. interest Liberty Bonds, due 9-15-21	31.88	
	Balance, cash on hand		184.55
	Total Receipts	$5702.90	$5702.90

Liberty Bonds on Hand—No. 15955—3rd issue..............$500.00
No. 472628—3rd issue..............1000.00

The reports of the Secretary and the Treasurer were referred to the Finance Committee which reported at a later session as follows:

REPORT OF FINANCE COMMITTEE

The Finance Committee have examined the accounts of the Treasurer and Secretary, have examined the reports which were referred to the Committee and find same to be in accord and correct.

FREDERICK A. REIMER,
Chairman, for the Finance Committee

Three committees were nominated from the floor, as follows:

Nominating Committee: Chairman, Frederick Giddings, Messrs. Kingsley, Tillson, Howell of Newark, Poole, of Rochester. Upon motion duly made and seconded nominations were closed and the Secretary cast the ballot, and the committee named was elected.

Committee on Place of Meeting: W. A. Howell, Chairman, Mr. Smith, of New York, Mr. Dalton, Mr. Hatton, Mr. Bastis. Upon motion duly made and seconded nominations were closed and the Secretary cast the ballot and the Committee named was elected.

Committee on Resolutions: Chairman, Mr. Folwell, of New York, Mr. Fisher of Rochester, Mr. Allen of Syracuse, Mr. Horner, Mr. Blanchard. Upon motion duly made and seconded nominations were closed and the Secretary cast the ballot, and the committee named was elected.

PRESIDENT COMPTON: Are there any amendments to the Constitution and By-Laws? If not, forever hereafter hold your peace.

A representative of the Near East Relief then gave a brief talk describing the work.

Adjourned at 12:30.

Tuesday Afternoon, October 25

The session was called to order at 2 p. m. by President Compton.

The following papers were presented.

Report of Committee on Street Lighting, C. W. Koiner, Chairman, being printed in Advance Papers was read by title. It will be found on page 371.

Street Lighting and Public Safety, by Earl A. Anderson, was read and illustrated by stereopticon. The paper and discussion will be found on page 1.

New Developments in Street Lighting, by C. A. B. Halvorson, was also illustrated and gave rise to discussion. Paper and discussion will be found on page 24.

Ornamental Street Lighting by L. A. S. Wood will be found on page 35.

PRESIDENT COMPTON: Before introducing the next speaker let me say that Baltimore was the first municipality to instal a municipal system of conduits and I believe she now has the largest system. Our present Mayor, when he was a member of the Council, about 25 years ago, introduced the ordinance which established the municipal conduit system in this city. Now, by virtue of his office, he is Chairman of the Electrical Commission. It gives me great pleasure to introduce Charles F. Goob who will speak to us on Electrical Conduits.

The paper, which was illustrated with stereopticon will be found on page 48.

The report of the Committee on Public Markets, presented by D. J. Sweeney, Chairman will be found, with the discussion thereon, on page 55.

The report of the Committee on Water Works and Water Supply was presented by Nicholas S. Hill, Jr., Chairman. It will be found with the discussion on page 60.

The session adjourned at 6:30 p. m.

Wednesday Morning, October 26

The session was called to order at 9 a. m. by President Compton.

The first paper, on the Water Supply and Filtration Systems of Baltimore, by J. W. Armstrong, will be found on page 90.

The second paper on the Pumping Stations and Water Distribution in Baltimore, by V. Bernard Siems, is on page 74, followed by the discussion thereof.

The report of the Committee on Sewerage and Sanitation was presented by T. Chalkley Hatton of Milwaukee, chairman. It will be found on page 101.

In connection with the paper Mr. Hatton presented a resolution, which was referred to the Committee on Resolutions:

MR. HATTON: I believe if the Society passes this resolution you will find within the next year or eighteen months a very great deal of valuable information coming into your hands thru the medium of the Federal Government on this very question, and those of you who are interested in sewage disposal plants, as I am, are fully convinced that something is vitally necessary to convince the public of the value of sewage sludge, and also to let your clients know that they can not dispose of their sludges in the unsanitary manner in which they are now being disposed of in the United States.

You gather that the idea is that this Committee is to act with the Agricultural Department of the United States Government to have it make these investigations, the committee to compile the statistics relating to the disposal of sewage sludges in the United States.

In explaining the last clause about the expense, I know that may strike some of you pretty heavy, but in my society work I have found that you can't get first-class committee work without paying the members of that committee their traveling expenses. Many of us are not prepared to go to meetings at our own expense, and we would not do it, whereas if the ordinary expenses of a Committee are paid, they would meet three or four times a year and discuss these problems just as we discussed the sewerage specification problems the other night, where Mr. Horner, the Chairman, stated that in all the time that he has been connected with that Committee he had never had such a splendid turnout and discussion as he had there. Why? Because all of our expenses probably are being paid to attend this Society and when we get here we are willing to talk. Now, unless you make it possible for the members of this Committee to meet, you will not have any definite and constructive work done, and if this Society is not able financially to pay the traveling expenses of its members it better go out of business. It is the only way you can do business.

The resolution as modified and reported by the Resolutions Committee later and adopted by the Society reads as follows:

Whereas, the rapid increase of sewage disposal plants in the United States is bringing to the attention of municipal officers the desirability of more economic and sanitary methods for disposing of the sludges produced from these plants; and

Whereas, recent developments in the art indicate that the problem may be best solved in many cases by the conservation and utilization of the fertilizing values contained in sewage sludges, and

Whereas, there is no one municipality properly equipped to make a general study of this problem, which is essentially a service which the Federal Government is especially equipped to perform;

Therefore be it Resolved, that the general committee on Sewerage and Sanitation of this Society be instructed to make special effort during the year to collect and compile detailed statistics relating to the production and disposal of sewage sludges within the United States and Canada, and on behalf of this Society, to bring to the attention of the Secretary of Agriculture of the United States, the problem of sludge disposal, requesting his co-operation in making prompt and exhaustive investigations of the possibility of conserving and making available to the agricultural interests the fertilizing values contained in sewage sludges produced from all sewage disposal processes established in the United States.

In the absence of Langdon Pearse, Chairman of the Sub-Committee on Sewerage, Mr. Hatton read the committee report, which took the form of a paper by Mr. Pearse on The Organization of Metropolitan Districts.

MR. HATTON: Mr. Pearse, in general, has tried to present to this Society as a part of its literature the various laws which have been passed, both in Canada and in the United States, for the bringing together of various municipalities into one big district, thus performing the services of water supply, sewerage, and light, removal of ashes, garbage collections, etc., in one great district. I know that it is going to be of use to the Society, because I have just passed thru the experience myself of trying to get the municipalities around the city of Milwaukee into one metropolitan district. I confess, gentlemen, that I spent months in trying to collect data which would enable me to draw up a law that would be just and popular with those people. That is why I suggested to Mr. Pearse that he write on this subject, and he has presented here the information that I could not get, because I did not know that it existed. Mr. Pearse has collected this for you in concise form and I hope the Society will find its way clear to print this paper in full, because I think it is one of the most valuable additions to our Society's literature.

The paper will be found on page 109.

Mr. Hatton also presented his paper on Dewatering Sewage Sludge, which will be found on page 104.

Mr. E. A. Fisher, Chairman of Sub-Committee B on Sanitation including Sewage Disposal presented a paper by Kenneth Allen, on The Sanitary Condition of New York Harbor and the Use of Fine Screens in New York City, which is printed on page 126.

Mr. N. Adelbert Brown's paper on Sludge Handling at the Rochester Sewage Disposal Plant, followed, as given on page 139.

Mr. John F. Skinner's paper on Sewage Disposal for Small

Municipalities completed the program of the morning. It will be found on page 142.

The session adjourned at 12 o'clock, noon.

Wednesday Night, October 26

The session was called to order at 8 p. m., First Vice-President Rankin presiding.

The first paper was read by Milton J. Ruark, engineer of sewers of Baltimore, on Miscellaneous Problems Connected with the Design and Maintenance of Sewerage Systems. It will be found on page 149.

It was followed by the report of Sub-Committee C on Public Comfort Stations as printed in Advance Papers. This report was illustrated by the stereopticon presented by H. F. Bascom, Chairman, and will be found on page 156, followed by the discussion.

The report of the Nominating Committee was read by Fred Giddings, Chairman, presenting the following list of nominations:

E. S. Rankin, Newark, N. J., President,
W. W. Horner, St. Louis, Mo., First Vice-President,
Ellis R. Dutton, Minneapolis, Minn., Second Vice-President,
Herman H. Smith, New York City, Third Vice-President,
Charles Carroll Brown, St. Petersburg, Fla., Secretary,
Linn White, Chicago, Ill., Treasurer,
E. L. Dalton, Dallas, Texas, Chairman,
S. Cameron Corson, Norristown, Pa.,
Joshua Atwood, Boston, Mass., members of the Finance Committee.

Motion was carried that the Secretary be instructed to cast the ballot of the Convention for the nominees presented, which was done and they were declared duly elected.

CHAIRMAN RANKIN: Gentlemen, I hardly know what to say on this occasion, but I certainly appreciate what you have done. When I think of the Convention that we are holding now, the success that it is meeting with, and when I also think that for the past ten years each Convention has been a little more successful than the one preceding, I look forward with a great deal of apprehension to what I will have to do for the next year if this record is to be maintained. However, it is really a matter which is up to the Society rather than to the President, and particularly to the Committees, for the main work of this Society is done, as you all know, by the Committees. I would like very much if any who are willing to serve on any Committee would give me their names before the close of this session. I can assure you I would appreciate it very greatly and it will assist me and help the workings of the next Convention. I will certainly endeavor to do my best to make the coming year a success, and I thank you.

Next is the Report of the Committee on Place of Meeting. The Committee was not ready to make a definite report and recommendation and the matter was referred back to the Committee, to make a report on the day following. The Chairman of the Committee was absent.

The Convention then listened to an address on The Park System of Baltimore, by J. Cookman Boyd of Baltimore, Md., Chairman of the Park Commission.

A report of the address will be found on page 166.

CHAIRMAN RANKIN: Thank you, sir.

MR. BOYD: I beg your pardon for talking so long and we will try to make good if you will come out with us and if you do not you will go away without having seen a great part of the improvements of this town. I, therefore, as the President of the Board invite you and your ladies as the guests of the parks on Friday next at two o'clock.

Secretary Brown received a telegram calling himself and E. C. Garvin, Director of Public Works, back to St. Petersburg on account of a severe tropical storm and the duties of secretary were performed thereafter by A. P. Folwell of New York, past president and formerly secretary for several years.

In the absence of the Chairman the Report of the General Committee on City Planning, Harland Bartholomew, Chairman, was presented as printed on page 171.

This was followed by the report of the Sub-Committee on Local Sub-divisions, read by Nelson P. Lewis, Chairman, as given with discussion on page 176.

The report of Sub-Committee B, on Zoning, was read by Chairman Joseph W. Shirley as printed on page 196.

The report of Sub-Committee D on Park Systems and Open Spaces was presented by John M. Rice, Chairman.

The session adjourned at 11 p. m.

Thursday Morning, October 27, 1921

The Thursday morning session was called to order at 9 o'clock by President Compton.

The report of the Finance Committee was made as printed on page 445. On motion it was accepted and ordered filed with the reports of the Secretary and Treasurer.

Chairman William A. Howell presented the Report of the Committee on Street Paving and Street Design, Street Maintenance and Street Railway Construction, as printed on page 219.

Chairman Kastberg's report of Sub-Committee A on Street Paving, was read by Mr. Howell. It will be found on page 227.

The next report was that of Sub-Committee B on Sidewalks and Street Design, E. R. Conant, Chairman, who spoke as follows:

MR. CONANT: Our duties so correlate with City Planning that I hardly know just what to submit to you, but have for consideration a paper on Street Designs by one of our members, Mr. P. L. Brockway. The paper will be found on p. 252.

The report of the Committee on Place of Meeting for 1922 was called for.

MR. HOWELL: We received invitations from Chicago, Asheville, North Carolina, Atlanta, Atlantic City, Detroit, Louisville, Los Angeles, Chattanooga, Birmingham, New York City, Philadelphia, Erie, Pa., Excelsior Springs, Mo., West Baden, Ind., Dubuque, Cleveland, New Profile House, White Mountains. The invitations that are really worth while, that are backed up by the municipal authorities and mean something come from Chicago, Minneapolis, Montreal, and Cleveland. The members of the Committee were practically evenly divided between Cleveland and Chicago. But we feel that Montreal and the other cities I have mentioned should also receive consideration. We therefore leave it to the better judgment of the entire Convention.

Motion was made by Mr. Reimer that the meeting be held in Cleveland.

MR. KINGSLEY: I want to second Mr. Reimer's motion and in seconding the motion I want to state that Cleveland sent us a very, very pressing invitation backed up by the Mayor, the other city officials and by the Chamber of Commerce and some other organizations in the city. We have never held a meeting at Cleveland and many of us would like very much to have a meeting held in the Ohio city. Perhaps not a small factor in coming to this decision, which I hope you will come to, is the fact that the National Paving Brick Manufacturers Association, an active Associate Member of this society, has done us a wonderful amount of good, and Mr. Blair especially has helped us in a great many ways and a great many times, and I feel our associate members are entitled to some consideration in meetings of this kind.

The motion was carried and Cleveland selected as the 1922 Convention City.

Mr. Rankin presents a resolution in regard to Standing Armies and Building of Warships, and the Disarmament Conference, which was referred to the Committee on Resolutions and will be found in that report.

Major Geo. H. Norton, Chairman, presented the Report of Sub-Committee C on Street Maintenance. It will be found on page 238.

The Report of Sub-Committee D on Street Railway Construction, C. A. Poole, Chairman, was called for.

MR. POOLE: There seems to be much uncertainty as to the scope of the work of this Committee and also duplications with the work of other committees. The Committee on Specifications for Street Railway Construction has prepared a very complete report which is published in the Advance Papers. They have collected the data of existing practice in a number of cities, and their report is a valuable contribution to the literature of the Society. When I received the questionnaire from the Chairman of the Committee on Specifications last year it was recognized that the work of these two committees was overlapping and covering the same ground and as the two other members of my Committee were also members of the Specifications Committee it did not seem advisable that they should make duplicate reports. I wish to give credit to the Committee on Specifications for the work they have done and while I believe that it was intended that our Committee should collect these data I am very glad that they have got them and wish to give them due credit.

Another matter that I think should be brought to the attention of the meeting on the question of Street Railway Construction is that it is of vital importance to another national society. That is the American Electrical Railway Engineers' Association. I have had some correspondence with Mr. H. H. George, who is in attendance at the meeting here as a guest of the Society, and is Chairman of the Committee on Ways of the Electrical Railway Association and he suggests that the two associations work in conjunction in making a report on this subject, especially in preparing the specifications. I would like to suggest to the Executive Committee that they give due attention to the advisability of instructing our committees on Street Railway construction to work in connection with the Electrical Railway Engineers' Association either by a joint committee or as they deem best.

PRESIDENT COMPTON: I believe if the general Chairmen of the main committees will get together with the new President you can straighten that up.

A paper on Granite Block Repaving in Baltimore was read by Nathan L. Smith. It will be found on page 317.

PRESIDENT COMPTON: This is not an attempt of the Chair to reopen the place of holding the next convention; but we want it understood that we are just as close to these other (Montreal) people as we ever were. No discourtesy was meant; and I would like to give Mr. Mullen an opportunity to say something.

MR. MULLEN: When I came here, I did not know there was a special invitation in from the City of Montreal, or I should have come prepared. As it is, I think the City of Cleveland got away with the next Convention too easily. I am not so urgent about the 1922 Convention, because in Montreal to-day we are building a very large hotel which will be all ready for the 1923 Convention; but, as I think a slight injustice has been done Montreal to-day, I want to suggest that preferential consideration be given to us for 1923, and I will see to it that there are urgent invitations.

Many things may be said in favor of Montreal. Some conventions are forced upon us these days; but the proper invitations go out to the organizations which we really wish to visit us. In Montreal, you will not have to put up signs like that in the corner there, which reads: " 'Testing' in room 401." We may do whatever "testing" we want to in Montreal; the only provision being that we do not do too much of it. I note that, down here where we cannot do it at all, some of us are very likely to do it too much. But the subject is closed: Cleveland has the Convention next year. I merely wish to ask that Montreal be given preferential consideration as the home of the following Convention in 1923.

A paper on Experimental Pavements in the Boro of Queens, New York City, was read by E. E. Butterfield. This paper did not reach the Secretary and must therefore be omitted, unfortunately.

The paper on Experimental Wood Block Paving in Minneapolis by W. A. McLean of the U. S. Forest Products Laboratory was read by Acting Secretary Folwell. It is found on page 240. The discussion follows the paper.

A paper not on the printed program on the Managnan-Sucher Process for Preserving and Transforming Wood was read by Arthur C. Smith as given on page 260.

Major E. B. Whitman's paper, held over from Tuesday afternoon, on The Relations between Public Service Commission and Municipalities was read by him. It is printed with the discussion on page 395.

A paper on Minor Repairs to Sheet Asphalt Paving by A. E. Christhilf of Baltimore was read by Acting Secretary Folwell. It is printed with the discussion thereof on page 272.

The Convention adjourned at 12:30 p. m.

Thursday Afternoon, October 27

The Convention was opened by President Compton at 2 p. m.

A paper on Cooperative Investigation by the U. S. Bureau of Public Roads upon the Cause and Correction of Shoving of Asphalt Pavements was read by Prevost Hubbard. The paper and its discussion will be found on page 264.

Major Geo. H. Norton presented illustrations and some additional material to his paper on The Economical Extent of Pavement Repairs and Maintenance, which was printed in

Advance Papers. It will be found with the discussion on page 275.

The next paper read was on Plant Inspection of Paving Material, by George Cobb, which is printed on page 308.

Charles E. Murphy, presented his paper on The Real Value of Highway Literature, as printed on page 327.

A paper on the Manufacture of Oil Asphalts was read by Herbert Spencer and will be found on page 296.

The paper on Properties of Mineral Aggregates Available in the Metropolitan District by E. E. Butterfield was read by title in the absence of the author. It will be found on page 311.

The report of the Committee on Specifications for Sheet Asphalt Pavement, Herman H. Smith, Chairman, was read by Acting Secretary A. Prescott Folwell, and was ordered printed in the Proceedings as follows:

REPORT OF COMMITTEE ON SPECIFICATIONS FOR SHEET ASPHALT PAVING

Herman H. Smith, Chairman, New York City

Your committee on Specifications for Sheet Asphalt Paving has considered the recommendations of last year's Committee, as to the complete revision of the specifications.

The present specification is too lengthy, contains too much detail, and is too much involved. In view of the time required to prepare a completely revised specification, no attempt was made to do so in time for action at this meeting. The specification adopted in 1918, together with its changes and additions adopted in 1920, provides a complete specification; which, altho as pointed out by last year's committee, may be improved upon in several particulars, represents prevailing practice, and its complete revision is a matter of sufficient importance to warrant giving it more time and thought than was possible prior to this meeting.

A tentative revised specification has been prepared, and has been considered at committee meetings during the Convention, and will serve as a basis for a complete revision such as the Committee hopes to bring about.

This tentative specification, and such data as have been collected, are available for use by the incoming committee, and it is to be hoped that a completely revised specification will be reported in time for publication in the advance papers of the next Convention.

MR. HOWARD: I certainly believe the specifications for sheet asphalt and asphalt concrete pavements should be revised. Just as we have complete tests by which we know whether or not a portland cement is a good cement and those tests are in our specifications and are used without respect to the brand or origin of portland cement, so we should have a standard set of tests, known to many, which asphalt cement must meet for use in hot-mixed asphalt pavements, with no reference to brand or origin of the materials from which it is made.

Therefore, I urge that in the new specifications for sheet asphalt pavements and asphalt concrete pavements, there be no mention of crude or refined asphalts or fluxes used, not any reference to kinds or origins of refined asphalts; but that we have in there a complete set of standard tests for asphalt cement. We would thereby eliminate extraneous influences and contentions as to the source of supply of crude and raw materials and place them on a square basis of quality of the asphalt cement, which is what actually goes into a pavement mixture and should have its physical and chemical qualifications, needed for quality, clearly set forth by tests to be made in any well equipped laboratory.

(By letter) I suggest the following *standard tests for asphalt-cement for use in sheet-asphalt and asphalt-concrete pavement compositions or mixtures.*

The *Asphalt-Cement* shall have the following qualities and meet the following tests made by standard methods of the A. S. M. I., and A. S. T. M., and as set forth herein.

(a) It must contain no water, coal or gas tar or their derivatives.

(b) It must be homogeneous and uniform.

(c) It must not be injured by water or contain any substance soluble in water.

(d) It must be ductile at 77° F., to be stretched at least 40 centimeters.

(e) Its specific gravity at 77° F. must be at least 1.00.

(f) Its penetration, degree of softness, at 77° F., must be between 35 (0.35 cm.) and 50 (0.50 cm.), according to the other materials in the pavement mixture, temperatures of local climate, weight of traffic, and as directed for each pavement and street or road; low penetration for heavy and higher for light traffic.

(g) Its freedom from volatile oil and safety for heating for use must be tested by the flash test, made in an open container about 3 inches in diameter across the top and about 1½ inches deep, with the thermometer bulb in the melted asphalt-cement. The flash point must not be below 400° F.

(h) Its stability against injury by heat in use and by weather action on the pavement is determined by exposing 50 grams in an open tin can 2¼ inches diameter, 1½ inches deep, 5 hours, in hot oven air, at 325° F., and must not lose more than 3 per cent. of its original weight.

(i) The penetration or degree of softness of the residue at 77° F., after test (h) must be at least 60 per cent. of its original penetration test (f); that is, test (h) must not harden it more than 40 per cent.

(j) The purity or pure bitumen content of the asphalt-cement used in any one pavement, determined by solubility in carbon bisulphide, must not vary more than ½ of 1 per cent. up or down.

(k) At least 99 per cent. of the pure bitumen of the asphalt-cement must be soluble in carbon tetrachloride at about 77° F.

(l) The asphalt-cement must have an average cementing strength (three tests) of at least 25 lb. per sq. in. (Howard or like method), when made into a hot and fully compressed (at 250° F.) briquette composed of standard Ottawa sand (20–30 mesh size grains), 90 parts by weight and 10 parts of the approximately pure bitumen of the asphalt-cement (or asphalt-cement itself when above 99 per cent. pure bitumen). These briquettes have the same shape and size as the standard Portland cement briquettes of the Am. Soc. C. E., and must be broken by tension at 77° F. in any briquette cement-testing apparatus used for Portland cement tensile tests.

REPORT OF COMMITTEE ON SPECIFICATIONS FOR BITUMINOUS MACADAM, BITUMINOUS CONCRETE AND ASPHALT BLOCK PAVEMENTS

Linn White, Chairman, Chicago, Ill.

Linn White, Chairman of the Committee on Specifications for Bituminous Macadam, Bituminous Concrete and Asphalt Block Pavements, presented the Committee's report in revised form, the original having been printed in Advance Papers.

On Mr. White's motion the report was adopted, and passed to letter ballot of the membership in accordance with the Constitution. The report follows and the result of the letter ballot will be found on page 425.

The report presented full specifications for bituminous concrete pavements, which were the same as the Specifications for Asphaltic Concrete Pavements adopted by the Society in 1916 with the following changes. For brevity and saving of expense the changes only are printed here in the form presented to the members for letter ballot. The changes having been adopted by vote of the Convention and letter ballot of active members the complete specifications in amended form as adopted by the 1922 Convention are printed in separate form and will be supplied to members on request made to the Secretary.

CHANGES IN SPECIFICATIONS FOR BITUMINOUS CONCRETE PAVEMENTS

Page 6, 4th line: After words "adverse conditions" substitute "*When the soil is unyielding and well drained and the traffic is light, the thickness of the base may be reduced to six (6) inches, and in some cases to less.*"

Page 7: For 2d, 3d, and 4th paragraphs under WEARING SURFACE substitute two paragraphs as follows:

The wearing surface shall have the prescribed thickness after thoro compression with a roller.

For ordinary traffic a thickness of two inches should be used. For heavy traffic 2½ inches will be sufficient and in some cases will be more stable than if thicker.

For 2d paragraph under MINERAL AGGREGATE substitute the following:

The stone shall be clean, hard, freshly crushed stone. It shall not contain sandstone or particles containing large crystals of feldspar or showing a marked plane of cleavage, and shall contain no particles that have been weathered or are soft. No stone will be accepted that has dust or any other material adhering to its surface. All of the stone shall pass a ¾-inch screen.

Third line from bottom: Change to read as follows:

passing a 200-mesh screen. There should not be over

Page 8: For the table and the first paragraph following it substitute the following:

Crushed Stone,	*52.5 to 60 per cent.*
Sand and Mineral Dust,	*34 to 40 per cent.*
Bitumen,	*6 to 7.5 per cent.*

A screening of the combined ingredients should give a grading within the following limits:

Bitumen	*6 to 7.5 per cent.*
Passing 200-mesh Screen,	*7 to 10 per cent.*
Passing 80-mesh Screen,	*5 to 15 per cent.*
Passing 40-mesh Screen,	*5 to 20 per cent.*
Passing 10-mesh Screen,	*5 to 15 per cent.*
Passing ¼-inch Screen,	*10 to 40 per cent.*
Passing ½-inch Screen	*10 to 40 per cent.*
Passing ¾-inch Screen	*0 to 10 per cent.*

Within these limits a great number of actual gradings may be obtained, but the materials should be so combined as to produce, when screened, from 50 to 55% coarser than 10-mesh. The maximum amount of bitumen should be used in mixtures containing the larger percentage of finer grades, particularly those passing the 80-mesh screen.

Following are actual analyses of samples of pavement laid under these specifications which have proven serviceable and may be classed as typical:

	No. 1	*No. 2*	*No. 3*
Bitumen.............	6.4	6.0	7.0
Passing 200-mesh Screen.	10.0	8.8	10.2
Passing 80-mesh Screen.	8.8	8.1	9.3
Passing 40-mesh Screen .	15.7	9.2	7.8
Passing 10-mesh Screen..	4.4	12.4	15.0
Passing ¼-inch Screen. .	14.0	36.2	42.0
Passing ½-inch Screen...	38.2	19.3	8.7
Held on ½-inch Screen...	2.5		

Page 10, second line from bottom: Omit "sub-".

Pages 12, 13, 14, 15: Omit Specifications for Bitulithic Pavement and letter.

PRESIDENT COMPTON placed Second Vice-President Horner in charge of the session.

The next report was by Harry F. Harris, Chairman of the Committee on Specifications for Broken Stone and Gravel Roads, with or without Bituminous Surface Treatment.

The report was as follows:

REPORT OF COMMITTEE ON BROKEN STONE AND GRAVEL ROADS WITH OR WITHOUT BITUMINOUS SURFACE TREATMENTS

Harry F. Harris, Chairman, Trenton, N. J.

The recent revision of the specification committees removed from the work of this committee several of the specifications adopted from time to time, and printed thruout the proceedings in the last several years.

In view of this fact, your committee believed that it would do well to bring the work of previous years, (beginning with 1916) up to date, by compiling and revising into one report the various specifications scattered thru several volumes of proceedings, omitting all the specifications now being handled by others.

In doing this it was thought several objects could be accomplished, namely:

1. The specifications would be in a much more convenient form for reference.

2. An opportunity would be given to bring the specifications more nearly up to date, and re-arrange them in more logical form.

3. It would also be possible for the specifications, with such changes as have been recommended, to appear in the proceedings in tentative shape for criticism during the current year, so that they could be finally adopted, with any necessary amendments, one year hence.

The specifications for Broken Stone and Gravel Roads have been retained practically as originally adopted, with only very few minor changes.

In order to avoid conflict with specifications of the American Society for Testing Materials for like products, we recommend the adoption of the tentative specification of that Society for high and low carbon tars for both hot and cold applications as surface treatment materials. Assuming that this recommendation is adopted, this will make it possible for the new committee of this Society to co-operate during the coming year with the A. S. T. M. committee, so that at next year's convention like recommendations can be made for final adoption to both societies.

Since no specification had ever been adopted for asphaltic oils for hot application, your committee presents such a specification herewith, as a tentative specification and for final consideration next year.

For cut-back asphalt cements we have recommended the retention of the existing specifications for cold applications.

During the war period cut-back asphalt cements were almost unobtainable for road making purposes, and your 1918 committee presented an alternative specifications known as "Temporary Substitute for Road Oil," which was for cold application. This specification was adopted and appears on page 362 of the 1918 proceedings.

Considering the fact that the cut-back material is still quite expensive, altho obtainable in large quantities, and that most excellent results have been obtained from using the substitute material, your committee recommends that this specification also be retained.

PROPOSED SPECIFICATIONS FOR BROKEN STONE ROAD

1. *General Description*—The broken stone road shall consist of three courses of broken stone, separately constructed, laid to conform to the required grades and cross-sections and constructed as hereinafter specified.

Broken Stone

2. *Quality of Broken Stone*—All broken stone shall be clean, rough surfaced and sharp angled, of compact texture and uniform grain.

Tests for Broken Stone—The broken stone shall be subjected to abrasion tests and toughness tests conducted by the engineer in accordance with methods adopted by the American Society for Testing Materials, August 15, 1908. It shall show a "French coefficient of wear" of not less than 7.0 and its toughness shall be not less than 6.0.

3. *Sizes*—The product of the crusher shall be passed over a rotary screen with sections having respectively circular openings of the following dimensions: First section, five-eighths (5/8)-inch holes; second section, one and one-quarter (1¼)-inch holes; third section, two and one-quarter (2¼)-inch holes; fourth section, three and one-half (3½)-inch holes. If so directed the first section of the screen shall be fitted with a dust jacket having one-quarter (¼)-inch openings so placed as to separate the dust from the product passing thru the first section. The screening plant shall also be fitted with a tailing chute so that no stone failing to pass the largest openings will fall into the bin for No. 4

size broken stone. The various sizes of broken stone shall be caught in separate bins, and shall be designated as follows:

Dust, all passing thru one-quarter (¼)-inch screen.

Screenings all passing thru five-eighths (⅝)-inch screen.

No.1 size, passing thru five-eighths (⅝)-inch screen and over one-quarter (¼)-inch screen.

No. 2 size, passing over five-eighths (⅝)-inch screen and thru one and one-quarter (1¼)-inch screen.

No. 3 size, passing over one and one-quarter (1¼)-inch screen and thru two and one-quarter (2¼)-inch screen.

No. 4 size, passing over two and one-quarter (2¼)-inch screen and thru three and one-half (3½)-inch screen.

Tailings, passing over three and one-half (3½)-inch screen.

Portable Plants—Portable crushing and screening plants shall be operated as directed.

Stationary Plants—If broken stone is to be supplied from stationary crushing and screening plants, the several sizes of broken stone shall not be used unless samples have been previously approved by the engineer. The various sizes of broken stone furnished shall be substantially the same as the samples approved.

Construction

4. *First Course*—After the sub-grade course shall have been prepared as specified, a course of No. 4 broken stone shall be evenly spread so that it shall have after rolling the required thickness of three and one-half (3½) inches. The depth of loose broken stone shall be gaged by the use of strings between iron stakes, as directed. The spreading of the broken stone must be from piles dumped on boards provided for the purpose or from piles dumped alongside the road, or as directed by the engineer. This course shall be thoroly rolled with a ten (10) to fifteen (15)-ton road roller. The rolling shall begin at the sides of the road and continue towards the center and shall be kept up until there is no disturbance of the stone ahead of the roller. After the completion of the rolling, no teaming other than that necessary for bringing on the broken stone for the next course shall be allowed over the rolled broken stone. Should it be apparent after the rolling of the first course that the subgrade material shall have become churned up into or mixed with the broken stone of this course, whether by reason of the rolling, or by hauling over the broken stone or otherwise, the contractor shall at his own expense remove and replace such mixture of sub-grade material and broken stone with clean broken stone of the proper size and shall roll the material to produce a uniform, firm and even first course as required.

5. *Second Course*—On the completed first course shall be spread, in the manner specified in the preceding paragraph, No. 3 broken stone to form the second course. This broken stone shall

be evenly spread to such a depth that it shall have after rolling the required thickness of two and one-half (2½) inches. After the second course shall be compacted under the same provisions as prescribed for the first course, it shall be evenly covered with a thin layer of screenings. The quantity of screenings to be used shall be just sufficient to cover the larger stones and care shall be exercised to avoid the use of an excess of the screenings. This covering shall then be rolled as heretofore provided. When the rolling shall have been completed the surface of the second course shall be firm, even and true to the lines, grades and cross-sections.

6. *Third Course*—On the completed second course shall be spread in the manner above specified for the first course No. 3 broken stone to form the third course. This broken stone shall be evenly spread to such a depth that it will have after rolling the required thickness of two and one-half (2½) inches. After the third course shall have been completed under the same provisions as prescribed for the first course, it shall be evenly covered with a thin layer of screenings. The quantity of screenings to be used shall be just sufficient to cover the larger stones and care shall be exercised to avoid the use of an excess of the screenings. This covering shall then be rolled as heretofore provided, except that water shall be used in connection with the rolling as follows: after the screenings shall have been lightly rolled, water shall be sprinkled on the road surface just ahead of the roller in such quantity as will prevent the sticking to the wheels of the roller of the fine material on the surface, and the combined spreading of screenings, watering and rolling shall be continued until the voids of the broken stone become so filled with the finer particles as to result in a wave of grout being pushed along the road surface by the front wheel of the roller. When the rolling shall have been completed the surface of the third course shall be firm, even and true to the lines, grades and cross-sections. After the third course has been compacted, puddled and filled as above specified, it shall be evenly covered with a thin layer of screenings. Should at any time, after its construction, and prior to the acceptance of the road, the larger stone be visible in the surface of the road, the contractor shall, without extra allowance, spread, sprinkle and roll sufficient screenings to completely cover the same.

Payment

7. *Measurement and Payment*—The quantity of broken stone road to be paid for shall be the number of square yards, measured horizontally, satisfactorily completed in accordance with specifications. The price stipulated shall include the furnishing, crushing and screening of the different sizes of broken stone, the placing, rolling and watering of the broken stone, and all work and expenses incidental to the completion of the broken stone road.

PROPOSED SPECIFICATIONS FOR BROKEN STONE ROAD WITH BITUMINOUS SURFACE

8. *General Description*—The broken stone road shall consist of three courses of broken stone, separately constructed, laid to conform to the required grades and cross-sections and constructed as hereinafter specified.

Broken Stone

9. *Quality of Broken Stone*—All broken stone shall be clean, rough surfaced and sharp angled, of compact texture and uniform grain.

Tests of Broken Stone—The broken stone shall be subjected to abrasion tests and toughness tests conducted by the engineer in accordance with methods adopted by the American Society for Testing Materials, August 15, 1908. The broken stone used for the construction of the first and second courses shall show a French coefficient of wear of not less than 7.0 and its toughness shall be not less than 6.0. The broken stone used for the construction of the third course and in connection with the bituminous surface shall show a French coefficient of wear of not less than 11.0 and its toughness shall not be less than 13.0.

10. *Sizes*—The sizes shall be in accordance with the requirements as stated in the paragraph entitled "Sizes" in the specifications for "Broken Stone Road."

Construction

11. *First Course*—After the sub-grade or sub-base course shall have been prepared as specified, a course of No. 4 broken stone shall be evenly spread so that it shall have, after rolling, the required thickness of three and one-half (3½) inches. The depth of loose broken stone shall be gaged by the use of strings between iron stakes as directed. The spreading of the broken stone must be from piles dumped on boards provided for the purpose or from piles dumped alongside the road, or as directed by the engineer. This course shall be thoroly rolled with a twelve (12) to fifteen (15)-ton road roller. The initial rolling shall begin at the sides of the road and continue towards the center and shall be kept up until the stone is keyed together and there is no disturbance of the stone ahead of the roller. After the first course has been compacted, it shall be evenly covered with a thin layer of screenings. The quantity of screenings to be used shall be just sufficient to cover the larger stones and care shall be exercised to avoid the use of an excess of the screenings. The covering shall then be rolled as heretofore provided, except that water shall be used in connection with the rolling as follows: After the screenings shall have been lightly rolled, water shall be sprinkled on the road surface just ahead of the roller in such quantity as will prevent the sticking to the wheels of the roller of the fine material on the surface, and the combined spreading of screenings,

watering and rolling shall be continued until the voids of the broken stone become so filled with the finer particles as to result in a wave of grout being pushed along the road surface by the front wheel of the roller. After the completion of the rolling no teaming other than that necessary for bringing on the broken stone for the next course shall be allowed over the rolled broken stone. Should it be apparent after the rolling of the first course that the subgrade material shall have become churned up into or mixed with the broken stone of this course, whether by reason of the rolling, or by hauling over the broken stone or otherwise, the contractor shall at his own expense remove and replace such mixture of sub-grade material and broken stone with clean broken stone of the proper size and shall roll the material to produce a uniform, firm and even first course as required.

12. *Second Course*—On the completed first course shall be spread, in the manner specified in the preceding paragraph, No. 4 broken stone to form the second course. This broken stone shall be evenly spread to such a depth that it shall have, after rolling, the required thickness of three and one-half (3½) inches. The second course shall be compacted, puddled with screenings and water, and finished under the same provisions as prescribed for the first course. When the rolling shall have been completed, the surface of the second course shall be firm, even and true to the lines, grades and cross-sections. If the surface is not slightly rough, so as to afford a sufficient mechanical bond for the third course, it shall be broomed.

13. *Third Course*—On the completed second course shall be spread, in the manner above specified for the first course, No. 3 broken stone to form the third course. This broken stone shall be evenly spread to such a depth that it will have, after rolling, the required thickness of two and one-half (2½) inches. The third course shall be compacted and puddled with screenings and water under the same provisions as prescribed for the second course, and when the rolling shall have been completed, the surface of the third course shall be firm, even and true to the lines, grades and cross-sections. After the third course has been compacted, puddled, and filled as above specified, it shall be evenly covered with a thin layer of screenings, sufficient to firmly bond the stone together. Each section of the broken stone road shall be subjected to traffic for at least one month before the construction of the bituminous surface thereon.

SPECIFICATIONS FOR SURFACE TREATMENTS WITH HOT BITUMINOUS MATERIALS

Note: The bituminous material under this designation may be refined tars indicated as "Refined Tar A," "Refined Tar B," or it may be an Asphaltic Oil. The selection of the type and character of the material being optional with the engineer.

HOT TARS

14. *Description of Bituminous Surface*—The bituminous surface shall consist of one application of refined tar covered with a top dressing of broken stone chips, pea gravel, grit, or other mineral matter, constructed as hereinafter specified.

Bituminous Material

15. *Refined Tar*—Refined tar used in the construction of the bituminous surface shall conform with either one of the specifications covering the chemical and physical properties of refined tar included under the item entitled "Refined Tars for Surface Treatments."

16. *Heating Refined Tar*—The refined tar shall be heated in kettles or tanks so designed as to admit of even heating of the entire mass, with an efficient and positive control of the heat at all times. It shall be heated as directed by the engineer to a temperature between 93 degrees C. (200 degrees F.) and 121 degrees C. (250 degrees F.) All refined tar heated beyond 121 degrees C. (250 degrees F.) shall be rejected. No tar shall be heated in kettles or tanks containing any oil or asphalt cement. Before changing from one type to another, kettles or tanks shall be scrupulously cleaned in order to avoid mixtures of the two. Any mixtures of different kinds of bituminous materials shall be rejected.

Thermometers Furnished by Contractors—The contractor shall provide a sufficient number of accurate, efficient, stationary thermometers for determining the temperature of the refined tar in kettles or tanks.

Construction

17. *Preparation of Surface of Road*—Prior to the application of the refined tar, the surface of the broken stone road, when thoroly dry, shall be swept clean of all dust, dirt or other loose material with horse or power-driven brooms of bass or other fine-fiber brooms, or with stiff-fiber hand brooms of bass or other fine-fiber brooms, as directed by the engineer. When the cleaning is completed the upper surface of the No. 3 broken stone shall be exposed, forming a clean mosaic surface.

In addition to the sweeping above specified, the shoulders on each side of the road, if of earth, for a distance of three feet (3′) shall be thoroly scraped with a blade grader in order to remove all dead material adjacent to the road metal and thus prevent the formation of a weak and brittle crust at this point after the application of the bituminous material.

18. *Application of Refined Tar*—After the surface shall have been cleaned to the satisfaction of the engineer, and when thoroly dry, the refined tar shall be uniformly applied over the prepared surface of the road by means of a pressure distributer as hereinafter specified and in accordance with the directions of the engi-

neer. The refined tar, when applied, shall have a temperature between 93 degrees C. (200 degrees F.) and 121 degrees C. (250 degrees F.). The total amount of refined tar to be used in the construction of the bituminous surface shall be applied in one application and shall not be less than one-quarter (¼) nor more than one-half (½) gallon per square yard, the precise quantity being determined by the engineer.

Pressure Distributer—The pressure distributer employed shall be so designed and operated as to distribute the refined tar specified uniformly under a pressure of not less than twenty (20) pounds nor more than seventy five (75) pounds per square inch in the amount and between the limits of temperature specified. It shall be supplied with an accurate stationary thermometer in the tank containing the refined tar, and with an accurate pressure gage so located as to be easily observed by the engineer while walking beside the distributer. It shall be so operated that, at the termination of each run, the refined tar will be at once shut off. It shall be so designed that the normal width of application shall be not less than six (6) feet and so that it will be possible on either side of the machine to apply widths of not more than two (2) feet. The distributer shall be provided with tires of widths dependent upon the following relationship between the pressure per square inch of tire and the diameter of the wheel; for a two (2) foot diameter wheel, five hundred (500) pounds shall be the maximum pressure per linear inch of width per wheel, an additional pressure of thirty (30) pounds per inch being allowed for each additional three (3) inches in diameter.

19. *Application of Top Dressing*—Immediately after the completion of the application of the bituminous material there shall be uniformly applied to the road at the rate of from twenty (20) to thirty (30) pounds per square yard, broken-stone chips, pea gravel, grit or other mineral matter which will meet the following requirements: (The exact amount to be applied should be determined in advance by the engineer, depending on the rate of application of the bituminous material and character of the top dressing.)

The broken stone, or pea gravel, grit or other mineral matter shall consist of clean, hard, tough, durable material, free from soft or disintegrated particles, dirt, or other objectionable matter.

When tested by means of laboratory screens it shall meet the following requirements:

Passing ¾ inch screen, not less than	85%
Retained on ¼ inch screen, not less than	85%

(Note: If a comparatively soft stone is used, the mesh composition of the top dressing may be increased in size so that at least 95% shall pass a one (1)-inch screen and at least 85% be retained on a one quarter (¼)-inch screen.)

20. *Seasonal and Weather Limitations*—No refined tar shall be applied when the air temperature in the shade is below 10 degrees C. (50 degrees F.), except by the written permission of the engineer.

Payment

21. *Measurement and Payment*—The quantity of broken-stone road with bituminous surface to be paid for under this item shall be the number of square yards, measured horizontally, satisfactorily completed in accordance with the specifications. The price stipulated in this item shall include the furnishing, crushing and screening of the different sizes of broken stone, the placing, rolling and watering of the broken stone, the heating and distributing of the refined tar, and all materials, work and expenses incidental to the completion of the broken-stone road with bituminous surface except the furnishing of the refined tar, which will be included for payment under the item entitled "Refined Tars for Surface Treatments."

Specifications for Refined Tars for Hot Surface Treatments

22. *Previous Service*—The contractor will be required to show to the satisfaction of the engineer that the company manufacturing the refined tar he proposes to use under a given specification has, for a period of at least two years, manufactured refined tar in a thoroly equipped plant; and that refined tar manufactured of bituminous material obtained from a similar source to that which he proposes to use shall have been in continuous and successful use in the surface treatment of broken stone roads for a period of at least two years previous to the date of the letting in which his proposal was submitted.

23. *Refined Tar "A," Optional With Refined Tar "B."* (*Low-Carbon for Hot Surface Treatment*)

1. The tar shall meet the following requirements:
   (a) Water.............................0.0 per cent
   (b) Specific gravity at 25°/25°C. (77°/77°F.)1.14 to 1.18
   (c) Float test at 32° C. (89.6° F.)..........60 to 150 sec.
   (d) Distillation test:
      Total distillate, by weight, 0 to 170° C.
         (32 to 338° F.)...................0.00 per cent
      Total distillate, by weight, 0 to 235° C.
         (32 to 455° F.)...not more than 4.00 per cent
      Total distillate, by weight, 0 to 270° C.
         (32 to 518° F.)....not more than 13.00 per cent
      Total distillate, by weight, 0 to 300° C.
         (32 to 572° F.)....not more than 26.00 per cent
      Residue...........not less than 74.00 per cent
   (e) Softening point (cube-in-water method) of
      residue from distillation test:
      ....not more than 75° C. (167° F.)
   (f) Free carbon..........not more than 5.00 per cent

Note: The above tests to be made in accordance with the methods of tests described under Serial Designation D 109-21 T of the American Society for Testing Materials.

24. *Refined Tar "B," Optional With Refined Tar "A." (High Carbon, for Hot Surface Treatment.)*

1. The tar shall meet the following requirements:
   (a) Water..............................0.00 per cent
   (b) Specific gravity at 25°/25° C. (77°/77°F.) 1.20 to 1.26
   (c) Float test at 32° C. (89.6° F.).........60 to 150 sec.
   (d) Distillation test:
      Total Distillate, by weight, 0 to 170° C.
         (32 to 338° F.)....not more than 0.00 per cent
      Total Distillate, by weight, 0 to 235° C.
         (32 to 455° F.)....not more than 10.00 per cent
      Total Distillate, by weight, 0 to 270° C.
         (32 to 518° F.)....not more than 15.00 per cent
      Total Distillate, by weight, 0 to 300° C.
         (32 to 572° F.)......not more than 25.00 per cent
      Residue.................not less than 75.00 per cent
   (e) Specific gravity at 25° C. (77° F.) of total
      distillate to 300° C. (572° F.)....not less than 1.03
   (f) Softening point (cube-in-water method) of
      residue from distillation test
      ....not more than 75° C. (167° F.)
   (g) Free carbon..............12.00 to 22.00 per cent

Note: The above tests to be made in accordance with the methods of tests described under Serial Designation D 109-21 T of the American Society for Testing Materials.

25. *Delivery*—The refined tar shall be delivered in suitable containers, far enough in advance of its use in the work to permit the necessary tests to be made. Each container shall be plainly labeled with the trade name of the refined tar, name of manufacturer, gross weight and net weight. Each shipment and each carload shall be kept separate.

Bills of Lading—The contractor shall furnish the engineer on or before the arrival of each shipment at or near the site of the work, bills of lading, or correct copies thereof, which shall state the trade name of the refined tar, and the name and address of the company manufacturing and supplying it.

Samples—Samples will be taken by the engineer from each carload of refined tar when delivered at the work, unless satisfactory arrangements can be made for sampling before shipment. Such samples shall be analyzed by the engineer to assure the delivery of a refined tar of the specified quality and to determine, for purpose of payment, the quantity of bitumen.

26. *Work Included*—Under this item the contractor shall furnish and deliver on the work at such points as directed refined tar which conforms with the specifications of either refined tar "A" or refined tar "B."

27. *Measurement and Payment*—The quantity of bituminous material to be paid for under this item shall be the number of

gallons placed on the highway in accordance with the specifications and requirements, or used as directed for other purposes. Bituminous material that is wasted by the contractor shall not be included in the measurement under this item. The price stipulated in this item shall include the cost of furnishing, hauling and delivering the bituminous material on the work, and all expenses incidental thereto.

The quantity of bituminous material paid for will be computed on the basis of its volume at 60° F.

ASPHALTIC OIL FOR HOT SURFACE TREATMENT, OPTIONAL WITH REFINED HOT TARS A OR B

(1) *Description of Bituminous Surface*—The bituminous surface shall consist of one application of asphaltic oil covered with a top dressing of broken-stone chips, pea gravel, grit or other mineral matter as hereinafter specified.

(2) *Preparation of Surface of Roadway*—After the surface of the roadway shall have been repaired, is well consolidated, and free from holes or depressions, and when thoroly dry, it shall be swept clean of all dust, dirt or other loose material with horse- or power-drawn brooms and bass or other fine-fibre brooms, or with stiff-fibre hand brooms and bass or other fine-fibre brooms. Newly constructed broken-stone or gravel roads shall be subjected to traffic for at least one month before the construction of the bituminous surface thereon.

In addition to the sweeping above specified the shoulders on each side of the road if of earth for a distance of three feet shall be thoroly scraped with a blade grader in order to remove all dead material adjacent to the road metal, and thus prevent the formation of a weak and brittle crust at this point after the application of the bituminous material.

(3) *Application of Bituminous Material*—After the surfaces and shoulders have been cleaned, the bituminous material shall be applied to the road from a pressure distributer at a rate of between one third (⅓) and one half (½) gallon per square yard. The asphalt when applied shall have a temperature between 135 deg. C (275 deg. F) and 177 deg. C (350 deg. F); the exact amount to be applied per square yard to be determined by the engineer.

(4) *Pressure Distributer*—The pressure distributer employed shall be so designed and operated as to distribute the bituminous material specified uniformly under a pressure of not less than twenty (20) pounds nor more than seventy-five (75) pounds per square inch in the amount and between the limits of temperature specified. It shall be supplied with an accurate pressure gage so located as to be easily observed by the engineer while walking beside the distributer. It shall be so operated that, at the termination of each run, the bituminous material will be at once shut off. It shall be so designed that the normal width of applica-

tion shall be not less than six (6) feet and so that it will be possible on either side of the machine to apply widths of not more than two (2) feet. The distributer shall be provided with tires of widths dependent upon the following relationship between the pressure per square inch of tire and the diameter of the wheel; for a two (2)-foot diameter wheel, five hundred (500) pounds shall be the maximum pressure per linear inch of width per wheel, an additional pressure of thirty (30) pounds per inch being allowed for each additional three (3) inches in diameter.

(5) *Application of Top Dressing*—Immediately after the completion of the application of the bituminous material, there shall be uniformly applied to the road, at the rate of from twenty (20) to thirty (30) pounds per square yard, broken-stone chips, pea gravel, grit or other mineral matter which will meet the following requirements: (The exact amount to be applied should be determined in advance by the engineer depending on the rate of application of the bituminous material and character of the top dressing.)

(6) The broken stone, or pea gravel, grit or other mineral matter shall consist of clean, hard, tough, durable material, free from soft or disintegrated particles, dirt, or other objectionable matter.

(7) When tested by means of laboratory screens it shall meet the following requirements:

Passing ¾-inch screen, not less than	85%
Retaining on ¼-inch screen, not less than	85%

Note: If a comparatively soft stone is used the top dressing may be increased in size, so that at least 95% shall pass a one (1) inch screen and at least 75% be retained on a one quarter (¼) inch screen.

(8) *Seasonal and Weather Limitations*—No bituminous material shall be applied when the air temperature in the shade is below 10° C. (50°F.), except by the written permission of the engineer.

(9) *Measurement and Payment*—The quantity of surface treatment to be paid for under this item shall be the number of square yards, measured horizontally, satisfactorily completed in accordance with the specifications. The price stipulated in this item shall include the furnishing and screening of the top dressing, the preparation of the roadway surface, the application of the bituminous material, and the spreading of the top dressing, and all materials, work and expenses incidental to the completion of the surface treatments, except the furnishing of the bituminous material, which will be included for payment under the item entitled "Asphaltic Oil for Hot Surface Treatment."

Specifications for Asphaltic Oil for Hot Surface Treatment, Optional with "Refined Tar "A" or "Refined Tar B"

The road oil shall be homogeneous, free from water, and shall not foam when heated to 120°C. (248° F.).

It shall meet the following requirements:

(1) Specific gravity 25°/25° C. (77°/77° F.) not less than 0.98.
(2) Flash point................not less than 80° C. (176°F.)
(3) Specific Viscosity 100° C. (212°F.)......not less than 60.
(4) Float test at 32°C. (89.6°F.)......not less than 60 seconds
(5) Loss at 163°C. (325°F.) 5 hours........not more than 15%
    a. Float test on residue 50°C. (122°F.)
    ....not less than 110 seconds.
(6) Total bitumen soluble in carbon disulphide
    ....not less than 99.5%
(7) Per cent of total bitumen insoluble in 86° B. naptha
    ....not less than 6.0%

Delivery. The bituminous material shall be delivered in suitable containers, far enough in advance of its use in the work to permit the necessary tests to be made. Each container shall be plainly labeled with the trade name of the bituminous material, name of manufacturer, gross weight and net weight. Each shipment and each carload shall be kept separate.

Bills of Lading. The contractor shall furnish the engineer bills of lading, or correct copies thereof, which shall state the trade name of the bituminous material and the name and address of the company manufacturing and supplying it.

Samples. Samples will be taken by the engineer from each carload of bituminous material when delivered at the work, unless satisfactory arrangements can be made for sampling before shipment. Such samples shall be analyzed by the engineer to assure the delivery of a bituminous material of the specified quality.

Work Included. Under this item the contractor shall furnish and deliver on the work, at such points as directed, bituminous material which conforms with the specifications for asphaltic oils or cements as specified.

Measurement and Payment. The quantity of bituminous material to be paid for under this item shall be the number of gallons placed on the highway in accordance with the specifications and requirements or used as directed for other purposes. Bituminous material that is wasted by the contractor shall not be included in the measurement under this item. The price stipulated in this item shall include the cost of furnishing, hauling and delivering the bituminous material on the work, and all expenses incidental thereto.

The quantity of bituminous material paid for will be computed on the basis of its volume at 60°F.

SPECIFICATIONS FOR SURFACE TREATMENTS WITH COLD BITUMINOUS MATERIALS

1. *Description of Bituminous Surface Treatment.* The bituminous surface treatment shall consist of one application of refined

tar or cut-back asphalt cement covered with a thin layer of top dressing as hereinafter specified.

Note: This specification provides for a surface treatment which may be used on thoroly cleaned broken-stone or gravel roads in good condition; for the re-treatment of tar surfaces or the maintenance of seal coats on tar-macadam or tar-concrete pavements, if refined tar is used for the surface treatment; or for the re-treatment of asphaltic macadam or asphaltic concrete pavements if cut-back asphalt cement is used for the surface treatment.

2. *Refined Tar and Cut-Back Asphalt Cement.*—The refined tar or cut-back asphalt cement, hereinafter referred to as bituminous material, used in the construction of the surface treatments shall conform with its respective specification covering the chemical and physical properties of bituminous materials included under the item entitled "Refined Tar and Cut-Back Asphalt Cement for Cold Surface Treatment."

3. *Preparation of Surface of Roadway.* After the surface of the roadway shall have been repaired, is well consolidated, and free from holes or depressions, and when thoroly dry, it shall be swept clean of all dust, dirt or other loose material with horse or power-drawn brooms and bass or other fine-fiber brooms, or with stiff-fiber hand brooms and bass or other fine-fiber brooms. Newly constructed broken-stone or gravel roads shall be subjected to traffic for at least one month before the construction of the bituminous surface thereon.

In addition to the sweeping above specified the shoulders on each side of the road, if of earth, for a distance of three feet shall be thoroly scraped with a blade grader in order to remove all dead material adjacent to the road metal, and thus prevent the formation of a weak and brittle crust at this point after the application of the bituminous material.

4. *Application of Bituminous Material.* After the surface shall have been cleaned, and when thoroly dry, the unheated bituminous material shall be uniformly applied to the prepared surface of the roadway by means of a pressure distributer as hereinafter specified, and in accordance with the directions of the engineer. The total amount of bituminous material to be used in the surface treatment shall be applied in one application and shall not be less than one-eighth (1/8) nor more than one-half (1/2) gallon per square yard, the precise quantity being determined by the engineer.

Note: The first treatment of broken-stone or gravel roads should consist of an application of between one-third (1/3) and one-half (1/2) gallon per square yard. Generally, subsequent treatments on the above types of roads, and bituminous pavements, should be less than one-third (1/3) gallon per square yard.

5. *Pressure Distributer.* The pressure distributer employed shall be so designed and operated as to distribute the bituminous material specified uniformly under a pressure of not less than twenty (20) pounds nor more than seventy-five (75) pounds per square inch in the amount and between the limits of temperature specified. It shall be supplied with an accurate pressure gage so located as to be easily observed by the engineer while walking beside the distributer. It shall be so operated that, at the termination of each run, the bituminous material will be at once shut off. It shall be so designed that the normal width of application shall be not less than six (6) feet and so that it will be possible on either side of the machine to apply widths of not more than two (2) feet. The distributer shall be provided with tires of widths dependent upon the following relationship between the pressure per square inch of tire and the diameter of the wheel; for a two (2)-foot diameter wheel, five hundred (500) pounds shall be the maximum pressure per linear inch of width of wheel, an additional pressure of thirty (30) pounds per inch being allowed for each additional three (3) inches in diameter.

6. *Application of Top Dressing.* Immediately after the completion of the application of the bituminous material, there shall be uniformly applied to the road at the rate of from fifteen (15) to thirty (30) pounds per square yard, broken stone chips, pea gravel, grit or other mineral matter which will meet the following requirements. (The exact amount to be applied should be determined in advance by the engineer depending on the rate of application of the bituminous material and the character of the top dressing.)

7. The broken stone, or pea gravel, grit or other mineral matter shall consist of clean, hard, tough, durable material, free from soft or disintegrated particles, dirt, or other objectionable matter.

8. When tested by means of laboratory screens it shall meet the following requirements:

Passing ¾-inch screen, not less than 85%
Retained on ¼-inch screen, not less than 85%

9. *Seasonal and Weather Limitations.*—No bituminous material shall be applied when the air temperature in the shade is below 10°C. (50°F.), except by the written permission of the engineer.

10. *Measurement and Payment.*—The quantity of surface treatment to be paid for under this item shall be the number of square yards, measured horizontally, satisfactorily completed in accordance with the specifications. The price stipulated in this item shall include the furnishing and screening of the top dressing, the preparation of the roadway surface, the application of the bituminous material, and the spreading of the top dressing, and all materials, work and expenses incidental to the completion of the surface treatments, except the furnishing of the bitumi-

nous material, which will be included for payment under the item entitled "Refined Tar and Cut-Back Asphalt Cement for Cold Surface Treatment."

Specifications for Refined Tars and Cut-Back Asphalt Cements for Cold Surface Treatments

11. *Previous Service.*—The contractor will be required to show to the satisfaction of the engineer, that the company manufacturing the bituminous material he proposes to use under a given specification has, for a period of at least two years, manufactured bituminous material in a thoroly equipped plant, and that the bituminous material which he proposes to use shall have been in continuous and successful use in the surface treatment of roadways for a period of at least two years previous to the date of the letting on which his proposal was submitted.

High Carbon Tar, Optional with Low Carbon Tar, or Cut-Back Asphalt Cement

1. The tar shall meet the following requirements:
   (a) Water..................not more than 2.00 per cent
   (b) Specific gravity at 25°/25°C. (77°/77°F.)...1.14 to 1.18
   (c) Specific viscosity, Engler, 50 cc. at 40° C. (104°F.).8 to 20
   (d) Distillation test on water-free material:
      Total distillate, by weight, 0 to 170°C.
         (32 to 338°F.)........not more than 7.00 per cent
      Total distillate, by weight, 0 to 235°C.
         (32 to 455°F.)........not more than 18.00 per cent
      Total distillate, by weight, 0 to 270°C.
         (32 to 518° F.)........not more than 28.00 per cent
      Total distillate, by weight, 0 to 300° C.
         (32 to 572°F.)........not more than 35.00 per cent
      Residue, by weight......not less than 65.00 per cent
   (e) Specific gravity at 25°/25°C. (77°/77°F.) of total distillate to 300°C. (572°F)..................not less than 1.01
   (f) Softening point (cube-in-water method) of residue from distillation test..........not more than 60°C. (140°F.)
   (g) Free carbon.................4.00 to 12.00 per cent

Note: The above tests to be made in accordance with the methods of tests described under Serial Designation D 104–21T, of the American Society for Testing Materials.

Low Carbon Tar, Optional with High Carbon Tar, or Cut-Back Asphalt Cement

1. The tar shall meet the following requirements:
   (a) Water..................not more than 2.00 per cent
   (b) Specific gravity at 25°/25°C. (77°/77°F.)..1.10 to 1.14
   (c) Specific viscosity, Engler, 50 cc. at 40°C. (104°F.).20 to 35
   (d) Distillation test on water-free material:
      Total distillate, by weight, 0 to 170°C.
         (32 to 338° F.)........not more than 2.00 per cent

Total distillate, by weight, 0 to 235° C.
(32 to 455°F.)........not more than 15.00 per cent
Total distillate, by weight, 0 to 270°C.
(32 to 518°F.)........not more than 30.00 per cent
Total distillate, by weight, 0 to 300°C.
(32 to 572°F.)........not more than 40.00 per cent
Residue...............not less than 60.00 per cent
(e) Softening point (cube-in-water method) of residue from distillation test.........not more than 70°C. (158°F.)
(f) Free carbon.........not more than 5.00 per cent

Note: The above tests to be made in accordance with the methods of tests described under Serial Designation D 105–21T, of the American Society for Testing Materials.

Cut-Back Asphalt Cement, Optional with Low and High Carbon Tars

The cut-back asphalt cement shall consist of a mixture of asphalt cement and naphtha, which will comply with the following specifications:

Its specific gravity at 25°/25°C. (77°/77°F.) shall be not less than 0.890.

When 20 grams of the material is maintained at a uniform temperature of 163°C. (325°F.) for 5 hours, in an open cylindrical tin dish 5½ centimeters (about 2¼ inches) in diameter, with vertical sides measuring approximately 3½ centimeters (about 1½ inches) in depth, the loss in weight shall be not less than 30 per cent nor more than 40 per cent.

When tested with a standard No. 2 needle under a load of 100 grams for 5 seconds at 24°C. (77°F.), the penetration of the residue, expressed in hundredths of a centimeter, shall be between 50 and 85.

When tested by means of the Engler viscosimeter at 25° C. (77°F.) the specific viscosity of the first 50 cubic centimeters passing the orifice of the viscosimeter shall be not less than 25 nor more than 35.

When distilled according to the Standard Method of the American Society for Testing Materials, the specific gravity of the distillate below 300°C. (572°F.) shall be not less than 0.730 nor more than 0.780.

Its bitumen, as determined by its solubility in chemically pure carbon disulphide at room temperature, shall be not less than 99.5 per cent.

Delivery.—The bituminous material shall be delivered in suitable containers, far enough in advance of its use in the work to permit the necessary tests to be made. Each container shall be plainly labeled with the trade name of the bituminous material, name of manufacturer, gross weight and net weight. Each shipment and each carload shall be kept separate.

Bills of Lading.—The contractor shall furnish the engineer bills of lading, or correct copies thereof, which shall state the trade name of the bituminous material and the name and address of the company manufacturing and supplying it.

Samples.—Samples will be taken by the engineer from each carload of bituminous material when delivered at the work, unless satisfactory arrangements can be made for sampling before shipment. Such samples shall be analyzed by the engineer to assure the delivery of a bituminous material of the specified quality.

Work Included.—Under this item the contractor shall furnish and deliver on the work, at such points as directed, bituminous material which conforms with the specifications of either refined tar or cut-back asphalt cement, as specified.

Measurement and Payment.—The quantity of bituminous material to be paid for under this item shall be the number of gallons placed on the highway in accordance with the specifications and requirements, or used as directed for other purposes. Bituminous material that is wasted by the contractor shall not be included in the measurement under this item. The price stipulated in this item shall include the cost of furnishing, hauling and delivering the bituminous material on the work, and all expenses incidental thereto. The quantity of bituminous material paid for will be computed on the basis of its volume at 60°F.

Temporary Substitute for Road Oil

Its specific gravity at 25°/25°C. (77°/77°F.) shall not be less than 0.835, nor more than 0.970.

It shall have a flash point of not more than 50°C. (122°F.) when tested in an open-cup oil-tester.

When tested by means of the Engler viscosimeter at 26°C. (77°F.) the specific viscosity of the first 50 cubic centimeters passing the orifice of the viscosimeter shall be not less than 80 nor more than 120.

When 20 grams of the material is maintained at a uniform temperature of 163°C. (325°F.) for 5 hours, in an open cylindrical tin dish 5½ centimeters (about 2¼ inches) in diameter, with vertical sides measuring approximately 3½ centimeters, (about 1½ inches) in depth, the loss in weight shall be not more than 30 per cent.

When the residue is tested by means of the New York Testing Laboratory float apparatus, the float shall not sink in water maintained at 50°C. (122°F.) in less than 90 seconds.

Its bitumen, as determined by its solubility in chemically pure carbon disulphide at room temperature shall be not less than 99.5 per cent.

It shall be soluble in 86° Beaume paraffin naphtha to the extent of not less than 94 percent of its bitumen as determined by clause next preceding.

PROPOSED SPECIFICATIONS FOR A GRAVEL ROAD

1. *General Description.*—The gravel road shall consist of three courses of mixtures of gravel, sand and clay, separately constructed, laid to conform to the required grades and cross-sections and constructed as hereinafter specified. The transverse slope of the finished surface of the gravel roadway shall be one (1) inch per foot.

2. *Subgrade.*—The subgrade for the gravel roadway shall consist of the natural earth roadbed prepared and rolled until firm, hard and even, and shall conform to the specified cross-section. If sandy or other soil be encountered which will not compact readily under the roller, a small amount of clay, or other means satisfactory to the engineer, shall be used until a firm, even surface is obtained after rolling. Where the proposed grade allows the use of an old roadway for the subgrade, the roadway shall be shaped and rolled to the specified cross-section and elevations and depressions removed so as to form an even surface before the construction of the first course. The roller used shall be a ten (10) to fifteen (15)-ton road roller.

3. *Shoulders.*—After the roadbed has been graded, shoulders of firm earth or other suitable material eight (8) inches in depth after compacting, shall be constructed on each side of the roadbed at such distances apart as may be required to retain the width of gravel specified. No material which contains weeds, sod, roots or other perishable matter and which will not compact under the roller shall be placed in the shoulders. The shoulders shall extend to the side ditches or gutters with the same transverse slope as required for the finished roadway surface and shall be thoroly rolled at the same time as the third or wearing course.

Materials

Quality of Gravel.—All gravel shall be hard and tough. Gravel which contains over 10 percent of disintegrated stone shall not be used.

Sizes.—Two mixtures of gravel, sand and clay shall be used, hereinafter designated in these specifications as No. 1 product and No. 2 product.

No. 1 product shall consist of a mixture of gravel, sand and clay, with the proportions of the various sizes as follows: All to pass a one and one-half (1½)-inch screen and to have at least 60 and not more than 75 per cent retained on a one-quarter (¼)-inch screen; at least 25 and not more than 75 per cent of the total coarse aggregate (material over one-quarter (¼) inch in size) to be retained on a three-quarters (¾)-inch screen; at least 65 and not more than 85 per cent of the total fine aggregate (material under one-quarter (¼) inch in size) to be retained on a two hundred (200)-mesh sieve.

No. 2 product shall consist of a mixture of gravel, sand and clay, with the proportions of the various sizes as follows: All to pass a two and one-half (2½) inch screen and to have at least 60 and not more than 75 per cent retained on a one-quarter (¼)-inch screen; at least 25 and not more than 75 per cent of the total coarse aggregate to be retained on a one (1)-inch screen; at least 65 and not more than 85 per cent of the total fine aggregate to be retained on a two hundred (200)-mesh sieve.

Test.—The mixture of gravel, sand and clay of the No. 1 product shall be subjected to a cementation test conducted by the engineer in accordance with the method recommended by the Special Committee on "Materials for Road Construction" of the American Society of Civil Engineers in January, 1916, and as described in the 1915 Proceedings, page 2738, except that the test shall be made on material which will pass a one-quarter (¼)-inch screen. Its co-efficient of cementation shall not be less than 50.

Construction

First Course.—After the subgrade or sub-base course shall have been prepared as specified, a course of No. 2 product shall be evenly spread so that it shall have, after rolling, the required thickness of three (3) inches. The depth of the No. 2 product loose shall be gaged by the use of strings between iron stakes, as directed. The spreading of the mixture of gravel, sand and clay must be from piles dumped on boards provided for the purpose or from piles dumped alongside the road. This course shall be thoroly rolled with a ten (10) to fifteen (15)-ton road roller. The initial rolling shall begin at the sides of the road and continue towards the center and shall be kept up until there is no disturbance of the No. 2 product ahead of the roller. After the first course has been compacted water shall be sprinkled on the roadway surface just ahead of the roller in such quantity as shall prevent the sticking to the wheels of the roller of the fine material on the surface, and the combined watering and rolling shall be continued until the voids of the gravel become filled with fine particles and until the roadway surface conforms to the specified cross-section. After the completion of the rolling no teaming other than that necessary for bringing on the No. 2 product for the next course shall be allowed over the rolled surface. The surface of the first course shall be maintained in its finished condition until the second course shall have been spread. Should it be apparent after the rolling of the first course that the subgrade or shoulder material shall have become churned up into or mixed with the material of this course, whether by reason of the rolling or by hauling over the surface, or otherwise, the contractor shall at his own expense remove and replace such mixture of No. 2 product and subgrade or shoulder material with No. 2 product and shall roll the material to produce a uniform, firm and even first course as required.

Second Course.—On the completed first course shall be spread, in the manner specified in the preceding paragraph, No. 2 product to form the second course. This mixture of gravel, sand and clay shall be evenly spread to such depth that it shall have, after rolling, the required thickness of three (3) inches. The second course shall be compacted, puddled with water and finished under the same provisions as prescribed for the first course. When the rolling shall have been completed, the surface of the second course shall be firm, even and true to the lines, grades and cross-sections.

Third Course.—On the completed second course shall be spread, in the manner above specified for the first course, No. 1 product to form the third course. This mixture of gravel, sand and clay shall be evenly spread to such a depth that it will have, after rolling, the required thickness of two (2) inches. The third course shall be compacted and puddled with water under the same provisions as prescribed for the first course. When the rolling shall have been completed, the surface of the third course shall be firm, even and true to the lines, grades and cross-sections. If necessary to satisfactorily bond the roadway surface, the third course shall then be evenly covered with a thin layer of sand or sand and clay and rolled.

Payment

Measurement and Payment.—The quantity of gravel road to be paid for shall be the number of square yards, measured horizontally, satisfactorily completed in accordance with the specifications. The price stipulated shall include shaping and rolling of the subgrade, the furnishing of the different products of gravel, sand and clay, the placing, rolling and watering of the several courses, and all work and expenses incidental to the completion of the gravel road. (The quantity of shoulders shall be paid for under a separate item.)

Note: The use of a bituminous surface treatment for gravel roads is not recommended under all conditions thruout the country. In certain sections gravel roads are constructed with local material carrying comparatively large percentages of clay in which case it is doubtful whether the success of such a treatment can be assured.

REPORT OF COMMITTEE ON SPECIFICATIONS FOR BRICK PAVING

George F. Fisk, Chairman, Buffalo, N. Y.

Your Committee on Brick Paving respectfully submits the following report:

Your Committee held two meetings during the year; one at Asbury Park, N. J., which was attended by three members and one at Cleveland, Ohio, at which all members of the Committee were present.

Your Committee has re-written the brick paving specifications, endeavoring to bring same up to date and give the Society specifications for the construction of the best type of brick pavements.

The Committee is brought to the conclusion that the economical use of vitrified brick for paving purposes forbids their restriction to a single type or to an iron rule of detail methods of construction, and that exception and alterations are necessary for most satisfactory results. Quoting from Public Works, Sept. 17, 1921—

"With demands for wire-cut brick, repressed, sharp edges, rounded edges, vertical fiber, etc., it does not seem possible that one standard can be adopted, but it does seem perfectly feasible to reduce the number to three or four, and it is to be hoped that such will be the result of the combined efforts of the various associations and departments now working to this end.

Your Committee gave considerable thought and discussion to a specification for plain wire-cut brick without lugs, for use with an asphalt filler applied by the squeegee method.

The Committee was informed that this type of brick paving has been used in an increasing extent in certain sections of the country and is now being specified by engineers in other sections.

The Committee decided, however, to hold the specifications open on this subject for another year, during which time further observation and investigation of this type of construction will be made by your committee.

Specifications for a tar mastic and also for an asphalt mastic bed were considered. The Committee was informed of the development in recent years of this type of construction, but also decided to hold this subject open for another year to give opportunity for further observation and investigation of this type of construction.

It is of special importance that brick pavements be placed upon the particular foundation best suited for economy and service of the pavement; that is, when a rigid base is used the brick wearing surface should be either a rigid type with cement grout filler or flexible type with a soft filler; when a flexible base (all other materials except cement concrete) is used, then only a flexible type of wearing surface should be used. The judgment of the engineer should be depended upon to properly adapt and adjust the principles as well as the details of construction to the variable conditions which confront him, not only in his city as a whole but on each separate project.

The specifications which follow are therefore offered as a guide for best results when properly related to the requirements of each project.

Motion was made for the adoption of the report and that the specifications should be sent out by the Society for letter ballot, as corrected, which was seconded and carried.

The specifications as adopted will be found on page 406.

The result of the letter ballot will be found on page 425.

The report of the Committee on Specifications for Cement Concrete Pavements, H. Eltinge Breed, Chairman, read by Acting Secretary Folwell was as follows:

REPORT OF COMMITTEE ON SPECIFICATIONS FOR CEMENT-CONCRETE PAVEMENTS

H. Eltinge Breed, Chairman

Your Committee on Specifications for Cement-Concrete Pavements wishes to make a progress report upon its work. Since the formation of the committee letters have been sent to each member requesting suggestions thru which the present specifications might be improved. Comparisons of approved specifications have been made. On the basis of replies and comparisons, tentative changes in the existing specifications might now be proposed, but such a report at this time would be incomplete and inadequate, and, because of its localized character, inapplicable to general usage.

The present specifications can be used thru the ensuing year, so your committee requests permission to continue its work until it can complete what it considers a satisfactory specification, with special attention to consistency, joints, reinforcement and curing.

With this specification your committee believes that it would be wise to present a supplementary report. Specifications approved by this society are extensively used by engineers, some times inexperienced, as a guide in doing work. Such specifications would, your committee believes, be more valued if amplified by specific illustrations taken from actual roads of modifications essential to good practice under varying conditions.

Such a report your committee hopes soon to have ready. It will be extremely grateful for suggestions from this meeting or from individual members.

Mr. Howard: I would suggest the Committee consider using the minimum amount of portland cement possible to obtain durable results.

Mr. Howard moved to adopt the report, which was seconded and carried.

REPORT OF THE COMMITTEE ON SPECIFICATIONS FOR WOOD BLOCK PAVEMENTS

Ellis R. Dutton, Chairman, Minneapolis, Minn.

Your Committee on Specifications for Wood Block Pavement has no recommendation to make for changes in the present specifications. These seem to be satisfactory and are being used with good results. There are some things, however, that it would be well to investigate and try out.

1st. See whether it would be advisable to reduce the depth of the block where it is laid according to the present specifications for a bituminous cushion.

2nd. See if there is some cheaper available creosoting mixture that would preserve the block as well as the present high-priced creosote oil.

3d. See if some other method of treatment would accomplish the desired penetration and preservative results using less oil.

These recommendations for work for the next committee are made with the object of reducing the number of alternate sections in the present specification and tending to further simplify and standardize the wood block specification, and at the same time, keeping up the high quality of the wood block paving but reducing the cost.

The report was accepted.

REPORT OF COMMITTEE ON SPECIFICATIONS FOR STONE BLOCK PAVING

R. A. Mac Gregor, Chairman, New York City

The Committee on Specifications for Stone Block Paving, reports and recommends the following changes and additions to the specification adopted by letter ballot Jan. 5, 1920.

Changes in Specifications for Stone Block Pavements

Note. Section numbers in the following changes are those used in the edition of the Specifications for Stone Block Paving adopted by Letter Ballot January 5, 1921.

Recut or Redressed Paving Blocks

6. Blocks cut from old paving blocks should comply with the specifications for quality of stone *and dressing* as required for new blocks. The dimensions may be varied, depending upon the size of the old blocks to be redressed.

Insert after 7

NOTE.—For use on old concrete foundations from which asphalt, wood or brick pavement has been removed, and to avoid raising the grade of the new pavement too much, a block 7 to 11 inches long, 3¾ to 4¼ inches wide and 3½ to 4 inches deep is on the market, and should be specified as similar in all respects, except size, to the standard block.

Cushion Course

10. Correct 2nd sentence to read . . . mixed 1 part portland cement to 4 parts sand.

Tar Pitch Filler, Asphalt Filler

13 and 14. First Paragraph, second sentence to read: The sand shall be clean, all passing a 10-mesh screen and 85% passing a 20-mesh screen.

And that these specifications as corrected, be sent out for letter ballot by the Society.

Motion was made, seconded and carried to accept the changes reported and pass them to letter ballot of the membership.

The result of the ballot will be found on page 425.

REPORT OF THE COMMITTEE ON SPECIFICATIONS FOR SIDEWALKS AND CURBS

S. Sammelman, Chairman, St. Louis, Mo.

Your Committee respectfully reports the adoption by letter ballot, of the specifications proposed at the Convention in 1920, the text of which may be found on pages 364–381 of the A. S. M. I. Proceedings of 1920.

During the past year tests were made by Messrs. C. E. P. Babcock, of Buffalo, N. Y., Monroe L. Patzig, of Des Moines, Iowa, and the Bureau of Public Roads, Washington, D. C., to determine whether or not the specification describing the qualification of stone for curb would exclude stones that have been in common use in certain localities for a number of years past. The tests so far made do not justify recommending any changes in the specification at the present time.

Prior to the 1922 Convention, the committee plans to determine as nearly as is practical to what extent the engineers are conforming to the present adopted standard.

It is deemed impractical, because of the short period of time since the adoption of the present specifications, to recommend any changes.

The report of the Committee was accepted.

REPORT OF THE COMMITTEE ON SPECIFICATIONS FOR SEWERS

W. W. Horner, Chairman, St. Louis, Mo.

Your Committee on Specifications for Sewers, at the last annual Convention, presented a tentative draft of the proposed Part 1 of the Sewer Specifications, dealing with materials for sewer construction. This draft was printed in the last proceedings of the Society, with a request for discussion.

During the year the Committee has received only two criticisms of this draft, and has made one modification dealing with weights and sizes of segmental block sewers.

The Committee has now prepared a tentative draft of Part 2 of the Specifications, dealing with methods of construction and an outline of the necessary general contract provisions, to complete the document. Your Committee was unable to meet during the year, but exchanged a remarkable amount of correspondence on this subject. The majority of the Committee, however, met in Baltimore, on October 22, and has had four lengthy sessions, one of which was an open meeting with members of the Society, in which was brought out the best discussion on Sewer Specifications which, to the knowledge of the Committee, has ever occurred in this Society. This discussion was of the greatest assistance in the final shaping up of the tentative draft, and it is recommended that an open meeting on this subject for the evening preceding the opening of the Convention be included in the programs of future meetings of this Society.

One of the duties imposed on your committee by instruction of the Society was to include in the sewer specifications such contract provisions as might be necessary to determine methods of estimating and paying for the work. The original draft of the specifications prepared by the committee contemplated the payment for the work at unit prices in considerable detail. One of the interesting developments of the meeting mentioned above was the evidence that the majority of those in attendance were accustomed to paying for sewer work on the linear foot basis. In the face of this showing the committee considered it advisable to prepare a specification including payment on the linear foot basis, but still feels that there is a decided advantage in the unit price basis, and is, therefore, submitting parallel drafts of the two types.

Your committee presents herewith complete tentative drafts of the Specifications for Sewer Construction. It recommends that the Secretary be authorized to have the drafts printed in the next proceedings of the Society, with the request for further discussion, with the expectation that after another revision the specifications can be presented for adoption at the next meeting.

Note:—At the request of Mr. E. S. Dorr, of the Committee, there is attached hereto a minority report prepared by him in the matter of the Measurement of Loose Rock Excavation. This is submitted for the information of the Society.

PROPOSED CONTRACT AND SPECIFICATIONS FOR CONSTRUCTING SEWERS

(*Payments by Unit Quantities*)

SEWER CONTRACT

THIS AGREEMENT, Made and entered into this day of ....A. D., 19........, by and between....

....

as Principal, and...............................

....

as Surety, parties of the first part, and the CITY OF..........
........party of the second, party, WITNESSETH:
WHEREAS, ...
of the said City of ....
by virtue of the authority vested in said......................
.............................., did let unto the said party of the first part the work of constructing sewers in..............

....

NOW, THEREFORE, In consideration of the payments and covenants hereinafter mentioned, to be made and performed by said second party, the first party hereby covenants and agrees to do the work above mentioned in a substantial and workmanlike manner in conformity with the plans of such work hereto attached and in accordance with the following:

SPECIFICATIONS

Plans scheduled below are to be considered a part of these specifications.

SCHEDULE OF DRAWINGS

Number
1. — (———)
etc.

Work to be Done

The contractor must examine the location of the proposed work in order that no misunderstanding may exist in regard to the character or general nature of the work to be done.

Nature of Work. The work to be done is to furnish all tools, materials and labor necessary and required, and to perform in accordance with the terms and specifications of this contract the work of making all necessary excavations and of constructing all sewers together with laterals, manholes, junctions and all other appurtenances thereto.

Prices

On all work the contractor will be paid for the amounts and quantities of work done and materials furnished of the following classes, the estimated quantities of which are respectively as follows:

Approximate Quantities

Class "A" excavation ....cubic yards
Class "B" excavation ....cubic yards

Class "C" excavation	cubic yards
Excavation below grade	cubic yards
Refilling below grade	cubic yards
Removing and replacing pavements	square feet
Piling	linear feet
Lumber for caps and framing	"M" ft. B. M.
Lumber left in trench	"M" ft. B. M.
Temporary bridges	square feet
Gravel or broken stone	cubic feet
Class (——) concrete	cubic feet
Boulders	cubic feet
Common brick masonry	cubic feet
Vitrified brick masonry	cubic feet
Hydrated lime	tons
Reinforcing steel bars, (——) Inches Square	pounds
Concrete invert finishing or lining	square feet
One-ring segmental block sewer, (———) inches in diameter	linear feet
Two-ring segmental block sewer, (———) inches in diameter	linear feet
Vitrified sewer pipe (———) inches in diameter	linear feet
Cement concrete pipe, (———), inches in diameter	linear feet
Reinforced concrete pipe, (———), inches in diameter	linear feet
(———) inch pipe underdrains	linear feet
(———) inch pipe slants	pieces
(———) inch "Y" or "T" junctions on segmental block sewers	pieces
(———) inch "Y" or "T" junctions on (———) pipe, (———) inches in diameter	pieces
Manhole steps	pieces
Manhole frames and covers	pieces
Inlet or catch-basin covers	pieces

DIVISION OF SPECIFICATIONS

Part I.—Materials.
Part II.—Methods of Construction.

PART I. MATERIALS

General Note

(1) All materials shall be subject to the inspection of the engineer and to tests herein outlined. Any material failing to pass the required tests shall at once be removed from the work. Failure to condemn material on preliminary inspection shall not be grounds for acceptance if future defects are found.

Cement

(2) All cement shall conform to the current specifications for portland cement of the American Society for Testing Materials, and shall be tested in accordance with the methods of testing described in the specifications of that Society.

(3) The engineer is to be notified of the location of wharves, yards or sheds where the cement is to be stored. No cement will be tested in cars, in course of transportation or on the street. All cement not satisfactory to the engineer is to be branded and immediately removed and all cement accepted by him to be so marked and kept in a weather tight store house, having a tight floor a proper distance above the ground. A sufficient quantity shall be kept in storage to allow for seven (7)-day tests, and if required, twenty-eight (28)-day tests. Cement kept in storage may be subjected to repeated tests. Cement in bags shall not be piled to a height exceeding seven (7) feet.

Hydrated Lime[1]

(4) Hydrated lime shall conform to the current specifications for hydrated lime of the American Society for Testing Materials and shall be tested in accordance with the methods of testing described in the specifications of that Society.

Sand

(5) Sand shall be of the best quality locally obtained and shall be clean, coarse, free from dirt, vegetable loam, organic acids or other deleterious matter. It shall contain not more than four (4) per cent by volume of clay and no clay shall be artificially added.

(6) *Grading for Mortar.* Sand for mortar shall be graded from fine to coarse and passing when dry a screen having ten meshes per linear inch and not less than ninety-four (94) per cent retained on a sieve having one hundred meshes per linear inch.

(7) *Grading for Fine Aggregate for Concrete.* Sand for fine aggregate for concrete shall be graded from fine to coarse and passing when dry a screen having holes one-fourth (¼) inch in diameter and not less than ninety-four (94) per cent retained on a sieve having one hundred meshes per linear inch.

(8) *Tests.* Sand shall be of such quality that mortars composed of the proportions of cement and sand hereinafter specified for the various classes of concrete shall show a compressive strength after fourteen (14) days at least equal to the strength of mortar made of portland cement and standard Ottawa sand in corresponding proportions and of the same consistency.

(9) *Samples.* Samples of not less than one-half (½) cubic foot of fine aggregate shall be delivered in suitable boxes or containers. All samples shall be plainly labeled with the places where taken, where to be used, the date and the name of the collector.

Coarse Aggregate

(10) *Quality.* Coarse aggregate shall consist of crushed stone, gravel or blast-furnace slag, which is retained on a screen having

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[1] NOTE.—Hydrated lime is commercially divided into four classes, high-calcium, calcium, magnesian and high-magnesian and the particular class of lime desired should be specified in each case.

holes one-fourth (¼) inch in diameter and graded from the smallest to the largest particles. It shall be sound, hard and durable; be free from loam, clay, organic matter and all deleterious material and shall not contain any soft, flat or elongated particles. Crusher dust in sufficient quantity to weaken the concrete will not be permitted.

(11) *Maximum Sizes.* For plain arches less than six (6) inches in thickness and reinforced arches where steel spacing is two (2) inches or less from face, the maximum size of particles shall be such as will pass a screen having holes one (1) inch in diameter. For inverts, plain arches over six (6) inches in thickness and reinforced arches where spacing of steel is greater than two (2) inches, the maximum size of particles shall be such as will pass a screen having holes one and one-half (1½) inches in diameter.

(12) *Samples.* Samples of not less than one (1) cubic foot of coarse aggregate shall be delivered in suitable boxes or containers. All samples shall be plainly labeled with the place where taken, where to be used, the date and name of the collector.

(13) *Tests.* Where crushed rock is used it shall have a specific gravity of not less than two and six-tenths (2.6) and shall have a French coefficient of wear of not less than eight (8) as described in bulletins No. 347 and 370 of United States Department of Agriculture.

Common Brick

(14) *Quality.* Common brick shall be sound, burnt hard entirely thru, of compact texture, with true even faces and rectangular edges. At least one edge face of each brick shall be such that if laid on a horizontal plane, no portion of that face shall be more than one-eighth (⅛) inch from that plane. Brick shall be regular in size and shape and for use on any one contract shall vary not more than one-eighth (⅛) inch in dimension.

(15) *Samples, Tests, Inspection.* Each shipment of between twelve thousand (12000) and twenty thousand (20000) brick shall be sampled. Each sample shall be subjected to cross breaking and crushing tests under the three (3) conditions given below, the brick to be tested flat and any unevenness in the surface to be levelled up with a plaster of paris bed.

(a) After having been thoroly dried.
(b) After having been immersed in water for twenty-four (24) hours.
(c) After being subjected to twenty (20) freezings alternating with twenty (20) thawings.

(16) The following figures fix minimum and average values to be met by the brick after the above treatment.

	Modulus of Rupture lb. per sq. in.		Crushing Strength lb. per sq. in.	
	Min.	Av.	Min.	Av.
(a) Dried..............	350	500	3000	4000
(b) Wet...............	300	450	2500	3500
(c) Frozen & Thawed...	225	275	2000	2500

(17) The absorption of the brick after immersion in water for twenty-four (24) hours shall not exceed fifteen (15) per cent of the weight of the dry brick.

(18) All brick must be satisfactory in every respect to the engineer and subject to his acceptance or rejection.

Vitrified Brick

(19) *Quality.* Vitrified brick shall be sound, uniformly vitrified and annealed, be free from lime or other impurities with true even faces and rectangular edges. At least one edge face shall be such that if laid on a horizontal plane, no portion of that face shall be more than one-eighth (⅛) inch from that plane. Brick shall be regular in size and shape and for use on any one contract shall vary not more than one-eighth (⅛) inch in dimensions.

(20) *Inspection.* All brick shall be satisfactory to the Engineer and subject to his acceptance or rejection.

(21) *Samples.* Brick shall be sampled and submitted to a standard Rattler Test and shall not show a loss of more than twenty-eight (28) per cent. This test shall be made according to the method adopted by the American Society for Municipal Improvements in 1914 for Paving Brick.

(22) *Tests.* Brick after having been thoroly dried and then immersed in water for twenty-four (24) hours shall not absorb more than four (4) per cent of their weight of water.

Vitrified Sewer Pipe[2]

(23) *Quality.* Sewer pipe shall be of the best quality of standard hard burned, salt-glazed, vitrified clay or shale pipe, shall be free from blisters, cracks and pronounced laminations and must give a metallic ring when struck with a hammer. All pipes shall be socket pipes with sockets true, circular and concentric with the base of the pipe and the plane of the ends at right angles to the axis of the pipe. The inner surface of the socket and the outer surface of the spigot end shall be scored by triangular shaped or semicircular rings about one-eighth inch deep.

(24) *Sizes and Dimensions.* Pipes shall be furnished of the sizes, internal diameter, and with the minimum dimensions given in the following table:

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[2] NOTE.—The tables of dimensions given in this specification for vitrified sewer pipe and cement concrete pipe are the same as adopted by the American Society for Testing Materials for the sizes specified. These two classes of pipe are considered to be a factory product and processes of manufacture and character of materials can be sufficiently standardized that dimensions can be specified. Reinforced concrete pipe, however, is nearly always a field-made product using a wide diversity of methods and many different grades of material, making the character of the finished product a variable proposition. For this reason no dimensions of pipes are specified, the only requirements being that pipes should satisfactorily pass certain tests.

Internal Diameter Inches	Laying Length Ft.	Inside Diam. at Mouth of Socket In.[3]	Depth of Socket In.	Minimum Taper of Socket In.	Thickness of Barrel In.	Thickness of Socket
6	2	8¼	2	1:20	⅝	The thickness of the socket ¼ in. from its outer end shall not be less than ¾ of the thickness of barrel of the pipe.
8	2, 2½, 3	10¾	2¼	1:20	¾	
10	2, 2½, 3	13	2½	1:20	⅞	
12	2, 2½, 3	15¼	2½	1:20	1	
15	2, 2½, 3	18¾	2½	1:20	1¼	
18	2, 2½, 3	22¼	3	1:20	1½	
21	2, 2½, 3	26	3	1:20	1¾	
24	2, 2½, 3	29½	3	1:20	2	
27	3	33¼	3½	1:20	2¼	
30	3	37	3½	1:20	2½	
33	3	40¼	4	1:20	2⅝	
36	3	44	4	1:20	2¾	

(25) The permissible variation from the dimensions given in the above table shall not exceed those stated below.

Internal Diameter in.	Limits of Permissible Variation in					
	Length in. per ft. (—)[4]	Length of two opposite sides in.	Internal Diameter		Depth of Socket in. (—)	Thickness of barrel in. (—)
			Spigot (±)	Socket (±)		
6	¼	⅛	3/16	¼	¼	1/16
8	¼	⅛	¼	5/16	¼	1/16
10	¼	⅛	¼	5/16	¼	1/16
12	¼	⅛	5/16	⅜	¼	1/16
15	¼	⅛	5/16	⅜	¼	3/32
18	¼	3/16	⅜	7/16	¼	3/32
21	¼	3/16	7/16	½	¼	⅛
24	⅜	¼	½	9/16	¼	⅛
27	⅜	¼	⅝	11/16	¼	⅛
30	⅜	¼	⅝	11/16	¼	⅛
33	⅜	⅜	¾	13/16	¼	3/16
36	⅜	⅜	¾	13/16	¼	3/16

(26) *Specials.* All special shapes shall have a plain spigot end and a socket end corresponding in all respects with the dimensions and specifications for pipes of corresponding internal diameter. Slants shall have their spigot ends cut at an angle of approximately forty-five (45) degrees with the longitudinal axis. Curves shall be at angles of ninety (90), forty-five, (45) twenty-two and one-half (22½) degrees as required and shall conform substantially to curvature specified. Branches shall be furnished with the connection or connections of the size or sizes specified, securely and completely fastened by fusion in the process of vitrification to the barrel of the pipe and shall terminate in sockets. "Y" branches shall have their axes approximately forty-five (45) degrees from the longitudinal axis of the pipe and "T" branches shall be perpendicular to that axis.

(27) *Inspection.* Pipes shall be subject to inspection either at the factory, trench or point of delivery, the purpose of this inspection to be to cull and reject pipe which, independently of

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[3] NOTE.—When pipes are furnished having an increase in thickness over that given in the last column, the diameter of socket shall be increased by an amount equal to twice the increase in thickness of barrel.

[4] NOTE.—The minus(—) sign indicates that the plus variation is not limited; the plus and minus (±) sign indicates variation in both excess and deficiency in dimension.

the physical tests herein specified, fail to comply with the requirements of these specifications.

Tests. The tests for pipe shall include the following.

(1) Sand-bearing Crushing Test.

(2) Hydrostatic Test.

(3) Absorption Test.

(28) Tests shall be made according to the methods described in the current Standard Specifications of the American Society for Testing Materials for Clay Sewer Pipe, and shall meet the requirements therein. One section shall be tested for each two hundred (200) linear feet or fraction thereof of each size of pipe to be laid, the minimum number of specimens to be tested to be six (6) for each selection of each size of pipe.

Cement Concrete Pipe

(See note to Section 24)

(29) *Quality.* Cement concrete pipe shall be made of Class "A" concrete as defined in these specifications and materials used shall meet the requirements of these specifications. Pipe shall be free from fractures, large or deep cracks and blisters, laminations and surface roughness. All pipe shall be socket pipe with sockets true, circular and concentric with the base of the pipe.

(30) *Sizes and Dimensions.* Pipes shall be furnished of the sizes, internal diameter with the minimum dimensions given in the following table.

Internal Diameter in.	Laying length ft.	Inside Diameter at mouth of Socket In.[5]	Depth of Socket in.	Minimum Taper of Socket	Thickness of barrel in.	Thickness of Socket
6	2, 2½	8¼	2	1:20	⅝	The thickness of the socket ¼ in. from its outer end shall not be less than ¾ of the thickness of the barrel of the pipe.
8	2, 2½, 3	10¾	2¼	1:20	¾	
10	2, 2½, 3	13	2½	1:20	⅞	
12	2, 2½, 3	15¼	2½	1:20	1	
15	2, 2½, 3	18¾	2½	1:20	1¼	
18	2, 2½, 3	22¼	3	1:20	1½	
21	2, 2½, 3	26	3	1:20	1¾	
24	2, 2½, 3	29½	3	1:20	2	

(31) The permissible variation from the dimensions given in the above table shall not exceed those stated in the following table.

Normal Size in.	Limits of Permissible Variation					
	Length in. per ft. (—)[6]	Length of Two Opposite Sides in.	Internal Diameter in		Depth of Socket in. (—)	Thickness of Barrel in. (—)
			Spigot (±)	Socket (±)		
6	¼	⅛	3/16	¼	¼	1/16
8	¼	⅛	¼	5/16	¼	1/16
10	¼	⅛	¼	5/16	¼	1/16
12	¼	⅛	5/16	⅜	¼	1/16
15	¼	⅛	5/16	⅜	¼	3/32
18	¼	3/16	⅜	7/16	¼	3/32
21	¼	3/16	7/16	½	¼	⅞
24	⅜	¼	½	9/16	¼	⅞

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[5] When pipes are furnished having an increase in thickness over that given in the last column, then the diameter of socket shall be increased by an amount equal to twice the increase in thickness of barrel.

[6] NOTE.—The minus sign (—) indicates that the plus variation is not limited; the plus and minus sign (±) indicates variation in both excess and deficiency in dimension.

(32) *Specials.* All specials shall have a plain spigot end and a socket end corresponding in all respects with the dimensions and specifications for pipes of the corresponding internal diameter. Slants shall have their spigot ends cut at an angle of approximately forty-five (45) degrees with the longitudinal axis. Curves shall be at angles of ninety (90), forty-five (45), Twenty-two and one-half (22½) degrees as required and shall conform substantially to curvature specified. Branches shall be furnished with the connection or connections of the size or sizes specified, securely and completely fastened in the process of manufacture to the barrel of the pipe and shall terminate in sockets. "Y" branches shall have their axes at an angle of approximately forty-five (45) degrees with the longitudinal axis of the pipe and "T" branches shall be perpendicular to that axis.

(33) *Inspection.* All pipes shall be subject to inspection either at the factory, trench or point of delivery, the purpose of this inspection to be to cull and reject pipes which, independent of the physical tests herein specified, fail to comply with the requirements of these specifications. Pipes shall be subject to rejection on account of the following:

(a) Variation in any dimension exceeding the permissible variations given in above Table.
(b) Fracture or cracks passing thru the shell or socket, except that a single crack at either end of a pipe not exceeding two (2) inches in length or a single fracture in the socket not exceeding three (3) inches in width nor two (2) inches in length will not be deemed cause for rejection unless these defects exist in more than five (5) per cent of the entire shipment or delivery.
(c) Blisters where the surface is broken or which project more than one-eight (⅛) inch above the surface.
(d) Defects which indicate imperfect mixing, molding or curing.
(e) Cracks sufficient to impair the strength, durability or serviceability of the pipe.
(f) Variation of more than one-eighth (⅛) inch per linear foot in alinement of a pipe intended to be straight.
(g) Failure to give a clean ringing sound when placed on end and dry tapped with a light hammer.
(h) Insecure attachment of branches or spurs.

Tests. The tests for pipe shall include the following:

(1) Sand-bearing Crushing Test.
(2) Hydrostatic Test.
(3) Absorption Test.

(34) Tests shall be made according to the methods described in the current Standard Specifications of the American Society for Testing Materials for Cement Concrete Pipe, and shall meet the requirements therein. One section shall be tested for each two hundred (200) linear feet or fraction thereof of each size to

be laid, the minimum number of specimens to be tested to be six (6) for each selection of each size of pipe.

Reinforced Concrete Pipe

(See note to Section 24)

(35) *Size and Shape.* Reinforced concrete pipe shall be made circular or egg-shape in cross section and circular pipe made in sizes from twenty-four (24) inches to ninety-six (96) inches inside diameter. Opposite diameters shall be true with a permissible variation of not more than three-fourths (¾) of one (1) per cent. They shall be in sections not less than three (3) feet in length and ends so formed that when laid together and cemented they shall make a continuous and uniform line of pipe.

(36) *Materials.* Pipe shall be made of Class "A" concrete and reinforcement. All materials used shall meet the requirements for the different classes of materials used as prescribed in these specifications.

(37) *Forms.* All pipe shall be made in forms composed of sheet steel cores and casings, and cast-iron bottom and top rings which form the joint. The forms shall be rigidly held together and the core and casing so placed as to insure a uniform wall thickness.

(38) *Air Curing.* The top rings, cores and casings shall not be removed from the pipe until the concrete has obtained its final set. Pipe shall not be lifted from the bottom rings until the concrete is from sixty (60) to seventy-two (72) hours old. After the cores and casings have been removed from the pipe, they shall be kept constantly and thoroly wetted by sprinkling with water at least three (3) times a day until they are removed from the bases and yarded. After being placed in the yard the pipe shall be sprinkled thoroly at least three (3) times a day until they are six (6) days old. Air-cured pipe are not to be laid until at least fourteen (14) days old.

(39) *Steam Curing.* Pipe may be cured by the use of wet steam in the following manner. After the pipes have been cast they shall be covered with canvas or other material known as steaming jackets and wet steam be turned into these jackets for one (1) day after casting. Then the casings and cores may be removed and steam again applied in the same manner for one (1) day. After this has been done the pipes may be removed from the bases and yarded, no other curing being necessary. Steam-cured pipes may be laid when they are six (6) days old.

(40) *Samples for Testing.* Any or all of the following tests may be applied to samples selected by the engineer for the pipe delivered on the work. For the purpose of making such tests the contractor shall furnish and deliver, when directed, five lengths of each size pipe used in the work.

(41) *Crushing Tests.* When supported at the bottom upon a knife edge one (1) inch in width, in such a manner that an even

bearing is provided thruout the whole length, exclusive of the bell, and load is applied at the crown uniformly thru a similar knife edge, the various sizes of pipe shall withstand, without failure, the loads shown in the following table.

Diameter Inches	Load Pounds per Linear Foot
24	2149
27	2369
30	2583
33	2830
36	3080
39	3300
42	3521

(42) When supported on a sand saddle which extends the full length of the pipe, exclusive of the bell, and whose upper surface fits accurately the outer curved surface of the pipe, and whose width is equal to an arc of fifteen (15) degrees, in such a manner that an even bearing is provided thruout the whole length, and the load is applied at the crown uniformly thru a knife edge one (1) inch in width, the various sizes of pipe with diameters greater than forty-two (42) inches shall withstand the following loads.

Diameter Inches	Load Pounds per Linear Foot
48	3800
54	4400
60	5000
66	5500
72	6000
78	6500
84	7000
90	7500
96	8000

(43) *Absorption Test.* The specimens for absorption test shall be sound pieces with all edges broken and may be from pipes broken in the crushing test. One specimen shall be taken from each pipe broken in the crushing test or it may be taken from other pipes. They shall be from twelve (12) to twenty (20) square inches in area and shall be as nearly square as they can be readily prepared. They shall be free from observable cracks, fissures, laminations or shattered edges. These specimens after being thoroly dried and then immersed in distilled, boiling water for five (5) hours shall not absorb more than twelve (12) per cent of their weight of water.

Steel Reinforcement

(44) *Material.* All steel reinforcement shall consist of cold-drawn steel-wire fabric having an elastic limit of not less than fifty-five thousand (55000) pounds per square inch, or of expanded metal having an elastic limit of not less than fifty-five thousand (55,000) pounds per square inch and expanded cold from sheets; or of reinforcing bars.

(45) *Bars.* Steels bars for reinforcing shall conform to the current specifications of the American Society for Testing Materials for (A) Billet Steel or (B) Rail Steel, except that rail steel bars may be used in sizes of one (1) inch and under only, and hot twisted bars will not be permitted.

(46) *Weights.* Dimensions of bars given on plans are based on square sections. The area and weight of bars shall not be less than ninety-five (95) per cent of the values for square bars as indicated. In computing the weights of steel, one cubic inch of steel shall be regarded as two hundred and eighty-three thousandths (0.283) of a pound.

Two-Ring Segmental Tile Blocks

(47) *Quality.* All segmental blocks shall be new and of the best quality of vitrified stone ware, thoroly burned and true to form. They shall be made in two (2) rings so that the blocks of one ring will interlock with those of the adjoining ring and the longitudinal joints of one ring will break joints with those of the other ring. The inner or wearing surface shall be evenly salt glazed and free from checks or fire cracks. All surfaces which will come in contact with the mortar in joints shall be scarified or grooved in order to secure a satisfactory bond.

(48) The least allowable total thickness of material from the inside face of the sewer to the nearest opening in the block shall be one and one-half (1½) inches for sewers thirty to forty-two (42) inches in diameter, one and three-fourths (1¾) inches for sewers forty-five (45) to fifty-four (54) inches in diameter and two (2) inches for sewers fifty-seven (57) to eighty-four (84) inches in diameter. The lengths of the blocks to be used on tangents shall not exceed twenty-four (24) inches and on curves twelve (12) inches. The thickness of the shell and the weight per linear foot of the sewer shall not be less than indicated in the following table.

Size Inside Diameter Inches	Thickness of Shell Inches	Weight per Linear Foot Exclusive of Mortar Pounds
30	4¾	250
33	4¾	275
36	4¾	300
39	5½	365
42	5½	395
45	5½	425
48	6	495
51	6	530
54	6⅛	605
57	6⅛	645
60	7¼	760
63	7¼	810
66	7¼	840
69	7¼	885
72	7½	940
75	7½	990
78	7¾	1065
81	7¾	1115
84	8¼	1290

(49) *Junctions.* Junctions for connections on segmental block sewers shall be made with "T" or "Y" branches. Where the size of the branch is such as to permit, it shall be burned on the block as an integral part thereof. Where the size is such that this cannot be done, openings of the necessary size shall be left in the block, into which the necessary pipe or slant shall be inserted and tightly cemented in.

(50) *Inspection Tests.* All blocks shall be satisfactory to the engineer and subject to his inspection or rejection. If the design of the block is such as to cause the engineer to doubt its strength for the work, the contractor may be required to make a loading test on a full size section before it is used in the work.

One-Ring Segmental Tile Blocks

(51) *Quality.* All blocks shall be new and of the best quality of vitrified stone ware, thoroly burned and true to form and shape. The ends shall be ship-lap jointed with abutting webs or surfaces to form a backing for mortar so as to insure tight joints on the ends of blocks. The inner or wearing surface shall be evenly salt-glazed and free from checks or fire-cracks. All surfaces which will come in contact with mortar shall be scarified or grooved in order to secure a satisfactory bond.

(52) *Thickness, Weights and Lengths.* The maximum length of block shall be twenty-four (24) inches, shorter lengths to be furnished where required for curves and specials. Blocks furnished on any one contract shall not vary more than one-fourth (¼) inch in width. The thickness of the shell and weight per linear foot of sewer shall not be less than indicated in the following table.

Size Inside Diameter Inches	Thickness of Shell Inches	Weight per Linear Foot Exclusive of Mortar Pounds
30	4¾	270
33	4¾	297
36	4¾	324
39	5½	377
42	5½	406
45	5½	435
48	6	504
51	6	555
54	6	592
57	6	629
60	6¾	774
63	6¾	817
66	6¾	860
69	7	900
72	7	945
78	8	1078
84	8	1176

(53) *Junctions, Inspection, Tests.* The provisions of the paragraphs titled "Junctions," "Inspection," "Tests" of these

specifications for "Two-Ring Segmental Tile Blocks" shall apply similarly to one-ring blocks.

Castings

(54) *Quality.* All castings for manhole heads, covers and other purposes must be of tough gray iron free from cracks, holes, swells and cold shuts. The quality shall be such that a blow from a hammer will produce an indentation on a rectangular edge of the casting without flaking the metal.

(55) *Workmanship.* All castings shall be made accurately to dimensions to be furnished and shall be planed where marked or where otherwise necessary to secure perfectly flat and true surfaces. Allowance shall be made in the patterns so that the thickness shall not be reduced.

(56) No plugging, burning in or filling will be allowed. Covers must fit the frames in any position. All castings shall be carefully coated, both inside and out, with coal-tar-pitch varnish. The varnish shall be made from a good quality of coal tar, with sufficient oil added to make a smooth coating, tough and tenacious when cold, and not brittle nor with any tendency to scale off. The castings shall be evenly heated to a temperature of 300 degrees Fahrenheit immediately before being dipped, and shall possess not less than this temperature when put in the vat; they shall remain in the vat five minutes unless otherwise directed by the engineer. The varnish shall be heated to a temperature of 300 degrees Fahrenheit, unless otherwise directed by the engineer, and shall be maintained at this temperature during the time the casting is immersed. Fresh pitch and oil shall be added when necessary to keep the mixture at the proper consistency and the vat shall be emptied of its contents and refilled with fresh material, when considered necessary by the engineer. After being coated the castings shall be carefully drained of all surplus varnish. No casting shall be allowed to become wet before being dipped. Any casting that is to be recoated shall first be thoroly scraped and cleaned.

Wrought Iron

(57) *Quality.* All wrought iron to be used on the work shall be of the class known as "Merchant Iron, Grade A," and must be free from cinder spots, injurious flaws, buckles, blisters or cracks. Wrought iron shall be made by the puddling process, or rolled from fagots or piles made from wrought-iron scrap, alone or with muck bar added. All iron shall have a minimum tensile strength of fifty thousand (50,000) pounds per square inch, an elastic limit of at least twenty-five thousand (25,000) pounds per square inch. A specimen cut from the iron, when nicked on one side and bent back thru an angle of one hundred eighty (180) degrees shall show a long, clean, silky fiber, free from slag, dirt or coarse crystalline spots.

(58) *Finishing Painting.* Wrought iron before leaving the factory shall be thoroly cleaned and dipped in a preparation of asphalt or coal tar and oil as described under "Castings."

Lumber

(59) Lumber shall be straight and sound, free from shakes, cracks, large or loose knots and other defects impairing its strength or durability. It shall be squared to the required dimensions thruout its entire length. Matched and grooved sheeting shall have one planed side.

Wood Piles

(60) All piling shall be sound, straight yellow pine, oak, cypress or other satisfactory timber, free from splits, shakes and all defects of weakening nature. All piles shall be peeled and knots trimmed close to the body of the pile. The minimum diameter at point and cut-off shall not be less than that given in the following table.

Length Below Cutoff Feet	Minimum Diameter at Point Inches	Minimum Diameter at Cutoff Inches
Less than 20	6	10
20–25	6	11
26–35	6	12
36–45	6	13
46 and over	6	14

Water

(61) Water used for concrete or mortar shall be clean and fresh and be free from oil, acid, alkalies or organic matter.

Joining Compounds

(62) Joining compounds shall have preferably a bituminous base, shall adhere firmly to the glazed surfaces of the pipes, shall melt and run freely at a temperature as low as two hundred and fifty (250) degrees F., and when set shall be sufficiently elastic to permit of a slight movement of the pipes without injury to the joints or breaking the adhesion of the compound to the pipes. The compound shall not deteriorate when submerged in fresh or salt water or normal domestic sewage. It shall show no deterioration of any kind when immersed for a period of five (5) days in a one (1) per cent solution of hydrochloric acid or a five (5) per cent solution of caustic potash.

PART II. METHODS OF CONSTRUCTION

Excavation

(1) *Classifications.* All excavation shall consist of three (3) classifications; namely, Class "A," Class "B" and Class "C."

(2) *Class "A" Excavation Defined.* Class "A" Excavation shall comprise solid rock in the original bed or well defined ledges,

and which can only be removed by continuous blasting; and all boulders or detached pieces of rock eight (8) cubic feet or more in content.[7]

(3) *Class "B" Excavation Defined.* Class "B" Excavation shall comprise all shale, soapstone, slate, hard-pan, fireclay, cemented gravel, macadam or telford pavements, brick masonry, except in pavements, and detached pieces of rock less than eight (8) cubic feet or more than one (1) cubic foot in content.

(4) *Class "C" Excavation Defined.* Class "C" Excavation shall consist of all materials not mentioned in Class "A" and Class "B" Excavation, or in the paragraph entitled "Removing and Replacing Pavements."[8]

(5) *Work Included in Excavation.* Under the headings Class "A," Class "B" and Class "C" Excavation is included the work of removing all obstructions on the surface of streets, alleys, rights-of-way, and public places; of making all necessary excavations not provided for in the paragraph headed "Removing and Replacing Pavements;" of furnishing and putting in place all shoring and bracing necessary to excavate and protect the work; of doing all pumping and bailing necessary to keep the trenches free from water; of providing for the uninterrupted flow of sewers and surface water and the temporary disposal of water from all other sources during the progress of the work; of protecting all pipes, conduits, culverts, street car and railroad tracks, poles, wires, fences, buildings and other public and private property along the field of operation; of removing after completion of the work all shoring and bracing not necessary to support the sides of the trenches; of hauling away all surplus excavation and material; of doing all backfilling; of restoring all property, injury to which is contemplated in this contract, and of restoring the surface and curbing of all streets, alleys and rights-of-way to as good condition as they were prior to the beginning of excavation, excepting where such work is included under the item "Removing and Replacing Pavements."

(6) *Payment.* Payment for Class "A," Class "B," and Class "C" Excavation shall be made at the respective prices bid per cubic yard, and the amount shall be full payment for all work done in connection with Class "A," Class "B" and Class "C" Excavation as described in the preceding paragraph.

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[7] NOTE.—In localities where limestones, which might vary by imperceptible degrees from shales and other stones, occur, the Chicago definition of rock is considered valuable. "Rock shall mean any material geologically in place, cemented into a mass by natural causes and of hardness when first exposed, of three (3) (the hardness of transparent calcite) or greater in the scale of mineral hardness. Frozen material shall not be classified as rock."

[8] NOTE.—It is the intention of the Committee, in the above classifications of excavation, to include all classes of excavation which there is a reasonable possibility of encountering. In localities where quicksand is known to occur and can be defined, its inclusion as a definite item in the contract is recommended. Quicksand may be defined as a material, the satisfactory excavation of which requires the use of close sheeting driven well below sewer grade, or the use of well points. In this instance, the price bid for quicksand should be required to include the cost of close sheeting, and of leaving in same up to the upper limit of quicksand excavation, and the furnishing and operation of well points, if used. If quicksand classification is inserted, it should be mentioned in subsequent clauses with classifications listed.

(7) *Open Cut and Tunnels.* In general, excavation shall be made in open cut from the surface and the contractor shall not be allowed to do any tunneling without obtaining permission from the engineer, and then only according to methods approved by him. This permission will only be given where a line is to be laid behind the curb, across a paved street, under street car or railroad tracks, or where, in the opinion of the engineer, it is necessary to tunnel short sections on account of proximity of adjacent walls or structures. Such excavation then can be made in alternate sections of open cut and tunnel, the length of the tunnel sections to be specified by the engineer and the head room in them to be not less than three (3) feet measured from the top of the sewer. These tunnel sections shall be cut underneath to a wedge with its edge horizontally across the sewer and backfilled tightly by tamping from each end.[9]

(8) *Excavation above Spring Line of Sewers Built in Place.* All excavation above spring line of sewers built in place will be estimated and paid for as a trench with vertical sides, the distance between which shall be one (1) foot greater than the outside horizontal dimensions of the masonry at the spring line.[10]

(9) *Class "B" and Class "C" Excavation Below Spring Line of Sewers Built in Place.* Class "B" and Class "C" excavation below spring line of sewers built in place shall be taken out and will be computed to the shape and outside dimensions of the masonry except in cases of special sections where the width of masonry is greater below than at spring line. In this case the trench line described in the preceding paragraph shall apply until it coincides with the outside of the masonry.

(10) *Class "A" Excavation and Concrete Refill Below Spring Line of Sewers Built in Place.* Class "A" Excavation below spring line of sewers built in place shall be made so as to conform as nearly as possible to the outside shape of the sewer wall, and a smooth bed made for the masonry by filling the uneven surface of the rock with Class "C" concrete or rubble masonry, this refill being carried up to the spring line whether above the rock surface or not. With monolithic concrete sewers, concrete of the same class as the sewer walls may, at the option of the engineer, be substituted for the Class "C" in the concrete refill. The amount of Class "A" excavation to be paid for below the spring line will be the area of a segment of a circle with its chord at the surface of the rock and a radius four and one-half (4½) inches larger than the radius of the outside of the sewer section. The amount of the concrete refill to be paid for will be the difference in area of two semicircles whose radii are respectively,

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[9] NOTE.—The above paragraph is only intended for short, isolated tunnels and should not be used for a regular tunneling specification. It was not considered feasible to write a general tunnel specification because of the large variation of local practice and of materials encountered. In localities where tunnel practice has not been well developed, it is recommended that experts in tunneling be retained to advise in the preparation of tunnel plans and specifications.

[10] NOTE.—For firm soils not requiring bracing or for rock easily shot to line, the width may be made equal to the width of masonry. For sections of irregular shape, pay lines should be shown on the plans.

equal to, and four and one-half (4½) inches greater than the outside of the sewer section. The outside of the sewer section for the monolithic concrete section shall be considered as the outside of a regular concrete section, of the brick sewer as the outside of a one-ring brick sewer, of the one-ring segmental block as the outside of a full block section and of the two-ring segmental block as a semicircle having a radius two and one-half (2½) inches larger than the inside radius of the sewer, the outer block being omitted in the latter type of sewer and the excess space filled with mortar.[11]

(11) *Class "B" and Class "C" Excavation for Vitrified and Premolded Pipe.* Class "B" and Class "C" excavation for vitrified tile and premolded concrete or cement pipe, will be estimated as a trench with vertical sides, a length equal to the distance from c. to c. of manholes and a width twelve (12) inches greater than the inside diameter of the pipe for pipe up to and including eighteen (18) inches; fifteen (15) inches greater than inside diameter for pipes twenty-one (21) to twenty-seven (27) inclusive and eighteen (18) inches greater for pipes thirty (30) inches or larger, provided that no trench shall have a width of less than thirty (30) inches. The depth of trench shall include the thickness of the pipe. Where rock is encountered in the trench, the width for Class "B" and Class "C" overlying excavation shall be the same as in the following paragraph.

(12) *Class "A" Excavation for Vitrified and Premolded Pipe.* Class "A" excavation for vitrified tile and premolded concrete or cement pipe will be estimated as described in the preceding paragraph, except that the width and depth of trenches in rock excavation shall be increased four (4) inches.

(13) *Excavation for Manholes.* Excavation for manholes will be considered as being included in the excavation for the sewer, unless the maximum outside width of manhole masonry is greater than the pay line width of trench, in which case the excavation necessary outside the pay lines will be estimated and paid for.

(14) *Underdrains.* Pipes for underdrains are to be laid below the sewer where directed by the engineer. They are to be laid with open joints, the joints wrapped in one thickness of muslin, the pipes bedded in gravel or broken stone and the refilling material placed solidly about them. "T's" for plugging the underdrains are to be turned up in the invert at such intervals as may be directed and the underdrains carefully plugged upon completion of the work. Excavation shall be made to the depth and width necessary and its area of cross section computed as a rectangular cross section. The trench shall be refilled with material specified by the engineer, which material shall be computed and paid for as the difference in area of the cross section of excavation and the outside cross section of the drain pipe. Pipe will be paid for by the linear foot at the price bid.

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[11] NOTE.—For shapes of inverts other than circular pay lines for excavation should be shown on plans.

(15) *Unusual Ground Conditions.* Where saturated ground is encountered and when it is the opinion of the engineer that such ground cannot be controlled by the ordinary methods of bracing, the engineer will instruct that other forms of bracing or sheeting be used. The excess in cost of such bracing or sheeting used over ordinary methods of bracing or shoring will be estimated and paid to the contractor, this amount to be the actual cost as determined by the Engineer plus fifteen (15) per cent.[12]

(16) *Excavation Below Grade.* If in the opinion of the engineer, the material at or below grade line, is of improper nature for a foundation, it is to be removed to such depths and widths and in such a manner as he may direct. Such excavation shall be refilled to grade with such materials as the engineer may direct, and confined in place by poling boards or vertical sheeting in a manner satisfactory to the engineer. Such excavation and materials used for refill will be estimated and paid for at the respective prices bid.

(17) *Disposal of Material.* Excavated material shall be so placed as not to unreasonably interfere with travel on the streets by the occupants of adjoining property or with access to fire hydrants. Such surplus excavation as is suitable shall be hauled and spread as directed on such property as is noted on the plans. Where directed, macadam, telford, gravel, street surfacing, surface loam, sod, etc., shall be kept separate from the remainder of the excavated material and replaced in its original position after backfilling of the trench. All surplus excavation, not disposed of as stated above, shall be removed from the site of the work by the contractor, but none shall be deposited on private property until written consent of the owner or owners thereof has been filed with the engineer. As before stated, all costs of disposal of surplus excavated material shall be included in prices bid requiring excavation.

(18) *Fences and Lights.* The contractor shall provide suitable fences around trenches and street obstructions and shall provide red cautionary lights at night, and watchmen when necessary.

(19) *Ownership of Excavated Material.* Underground structures removed, such as brick, sewer pipe, etc., shall become the property of the contractor unless otherwise noted on the plans. Where noted on the plans, such structures are to be carefully removed, separated into convenient units for handling and conveniently placed for removal by the city.

(20) *Bracing and Shoring.* The sides of all trenches shall be securely held by bracing and sheathing which, if not ordered left in, may be removed in units when the level of the backfill has reached their elevation. When, in the opinion of the engineer,

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[12] NOTE.—In making plans for any sewer job the engineer should, if he anticipates encountering quicksand, saturated ground, etc., show on his plans and in his specifications exactly how he proposes to take care of it, and cover the cost of the work by the necessary bid items. The above clause is only intended to apply in case such conditions are encountered unexpectedly during the progress of the work.

sheeting or shoring cannot be safely removed, it shall be left in place, or if he so desires, the sheeting shall be cut and the upper part withdrawn. The contractor shall be paid for the lumber so left in place or withdrawn at the prices bid, but no payment will be made for sheeting cut off and removed in excess of eight (8) feet in length; of which not more than two (2) feet shall be above the surface. Timber left in place shall be cut off at least two (2) feet below the surface. Payment for matched and grooved sheeting will be made in each case for the length of trench occupied by such sheeting, with no allowance for wastage due to tongues and splines respectively. In the case of timber, no thickness of sheeting over two (2) inches and no other lumber exceeding in size that customarily used, shall be paid for unless the use of such large sizes shall have been ordered in writing by the engineer.

(21) *Temporary Bridges, Crossings.* The contractor shal where ordered, construct bridges, crossings, etc., the surfaces of the bridges being flush with the street. The bridges shall be capable of supporting at any point a wagon load of three (3) tons on each wheel, or its equivalent, without inducing fiber stresses in beams greater than one-thousand (1000) pounds for wood, and sixteen thousand (16000) for steel, per square inch. Bridges or crossings so ordered, will be paid for by the square foot of floor area according to the dimensions ordered put in by the engineer.

(22) *Restoration of Surface of Ground.* During the construction of the sewer all work of keeping alleys and rights-of-way in a passable condition by refilling sunken ditches, laying temporary paving over trenches, etc., shall be done in a manner satisfactory to the engineer. If any such work is not done within five (5) days after written notice given by the engineer, the work may be done by the city and the expense thereof be paid by the contractor or deducted from sums due the contractor under this contract.

(23) *Amount of Trench.* Without the written permission of the engineer, not more than two hundred (200) feet of trench shall be opened in advance of the completed sewer, and in rock work not less than thirty (30) feet in advance of the completed sewer.

Removing and Replacing Pavements

(24) *Work Included.* Under the heading "Removing and Replacing Pavements" is included the work of tearing up such areas of pavement other than macadam or telford, as may be required for the construction of sewers therein, of placing a temporary pavement to carry traffic until such time as the permanent pavement may be laid, and of permanently repaving these areas after the backfill has settled.

(25) *Temporary Pavement.* In placing the temporary pavement, the backfill shall be compacted or flushed as directed,

up to the level of the pavement subgrade, after which the remainder shall be filled with crushed stone or gravel bonded with limestone screenings and compacted as far as possible without requiring the use of a roller. This temporary pavement may be crowned at the discretion of the engineer, but in no case shall this crown be more than three-fourths (¾) inch in height for each foot of width of trench. The contractor shall maintain this temporary pavement in condition adequate for its usual traffic, until such time as it is replaced by the permanent pavement, and shall pay any claims or damages arising from his neglect to maintain the temporary roadway.

(26) *Permanent Pavement.* The permanent pavement shall be laid at such time as the engineer may permit, but in no case in less than six (6) months after the trench was backfilled nor more than one (1) year after the temporary pavement was laid. The contractor shall replace the permanent pavement during the above stated period upon receipt of notice from the engineer. Such replacement must be made under city inspection and in accordance with the city standard specifications for the kind of pavement to be laid.

(27) *Payment.* The contractor will be paid for work done under this paragraph by the square foot at the price bid for "Removing and Replacing Pavements" and the amount to be paid for shall be determined by the length of pavement actually disturbed with a width two (2) feet greater than the pay line width of the trench. If a greater width of pavement shall have become displaced, the contractor shall satisfactorily restore such at his own expense.

Piling

(28) *Driving.* Piles, of the quality specified under Part I of these specifications, are to be furnished and driven by the contractor as shown on plans or as directed by the engineer. They are to be replaced by the contractor at his own expense where broken in driving or where driven off line. Piles are not to be driven until the trench has been excavated to the grade line.

(29) *Cut Off.* Each pile is to be cut off by the contractor exactly level, so that the cap or masonry which rests on it will have a firm and even bearing.

(30) *Caps.* Pile caps if used are to be of the dimensions shown on the plans or as directed by the engineer, and are to be securely fastened to the piles by oak tree-nails or by bolts and washers.

(31) *Payment.* In determining the length of new pile to be paid for, the part sawed off is not to be deducted unless it exceeds two (2) feet in length, in which case all but two (2) feet of the part sawed off is to be deducted. Caps, if used, will be paid for by the board foot at the price bid which shall include the cost of fastenings.

Concrete

(32) *Definition.* Whenever the term "Concrete" is used herein, it is understood to mean an intimate and homogeneous mixture of cement, sand and coarse aggregate with sufficient water.

(33) *Proportions.* Concrete shall be of four classes proportioned as followed:

Class	Cement Sacks	Sand Cu. ft.	Coarse Aggregate Cu. Ft.
A	1	2	4
B	1	2½	5
C	1	3	6
D	1	4½	9

In the case of concrete used in sufficiently large masses, and of such consistency as to allow of packing without settlement, boulders not exceeding one-half (½) cubic foot in volume may, at the option of the engineer, be placed therein by hand, in such manner that each stone is surrounded by not less than four (4) inches of concrete. Boulders so used will be paid for by volume, two thousand (2000) pounds of boulders being considered as being equivalent to one-half (½) cubic yard. The volume of boulders shall be deducted from the total volume of concrete, the remainder being the amount of concrete which will be paid for.[13]

(34) *Mixing by Machine.* The concrete mixer shall be designed to take one complete batch of materials, (using whole bags of cement), and to mix that batch thoroly before any portion of it is withdrawn or any proportion of the succeeding batch is introduced. The mixer shall be equipped with a tank so designed that when once set it will automatically supply to the mixer the amount of water so determined. The mixer shall be equipped with an instrument for measuring the time of mix. Concrete shall be mixed at least one (1) minute after all the ingredients, including water, have been discharged into the mixer. Where the character of the work will permit, concrete shall be mixed in batches of one-half (½) to one (1) cubic yard and the mixer speed shall not be less than twelve (12) nor more than nineteen (19) revolutions per minute. Where small mixers are used, the speed shall not exceed twenty-two (22) revolutions per minute.

(35) *Hand Mixing.* Where concrete is mixed by hand, the cement and sand shall be mixed dry on a properly constructed wooden or steel platform, until it shall have an even and uniform

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[13] NOTE.—For concrete sewer projects of considerable magnitude, where facilities are available for careful analysis of the aggregates and for making compression tests of concrete, the committee recommends a study of the 1921 Report of the Joint Committee on Concrete and Reinforced Concrete. In such cases it may be advisable to specify concrete strengths and the use of Abrams tables of proportions.

color thruout. This mixture shall then be spread to make a bed of uniform thickness, on which shall be spread the coarse aggregate and the whole wet with the required amount of water and turned with square-pointed shovels until a uniform mixture is secured, water being added from time to time if necessary.

(36) *Consistency.* In mixing concrete, it is advisable to use the least amount of water required to obtain a workable mix, and when the aggregate is dry, six (6) gallons of water to a sack of portland cement is the maximum which should be used. Where a comparatively dry mix is to be used, as in inverts and near the crown of arches, the concrete must be thoroly tamped until the water flushes to the surface.

(37) *Work in Freezing Weather.* When the temperature falls below thirty-two (32) degrees Fahrenheit all the materials which enter into the construction of masonry of any kind are to be thoroly heated and used while hot. For brick masonry and pipe joining this is to be done by heating the brick and sand and the water with which the mortar is used. For concrete masonry, it is to be done by heating the aggregates and water with which the concrete is mixed. As soon as the mortar or masonry is placed it is to be protected from frost, either by backfilling or by covering with hay, straw, manure, or some similar substance, to a depth of at least one (1) foot. A covering of canvas or boards will not be considered sufficient but where steam is available, and it is practicable to cover all exposed masonry with canvas and introduce steam underneath the canvas, it will be deemed a sufficient protection to do so. When the temperature falls to or below twenty (20) degrees Fahrenheit no mason work of any kind is to be done except by special permission of the engineer, and strictly according to his directions, provided that masonry may be laid in trenches twelve (12) feet or more in depth and width not exceeding one-third (⅓) the depth.

Concrete Sewers Built in Place

(38) *Line and Grade.* Concrete sewers shall be constructed to the alinement, grade and dimensions indicated on the plans or as designated by the engineer.

(39) *Machine and Hand Mixing.* Concrete shall be machine mixed except in emergencies or on isolated small jobs, when hand mixing may be allowed upon express permission from the engineer. Both machine and hand mixing shall be done as specified under "Concrete."

(40) *Transporting Concrete.* Provision shall be made for quickly transporting the concrete from the mixer to the work with as little shaking as possible, so that the tendency of water to rise to the top may be reduced to a minimum. Any concrete which may have been compacted during transportation shall be remixed before being placed in the work. Any concrete delayed more than one-half (½) hour in transit shall not be used in the work.

(41) *Placing Concrete.* Concrete shall be deposited so as to maintain a nearly level surface and avoid flowing along the forms. It shall be continuously and sufficiently worked to expel air and to force the aggregate away from the forms. In special cases where concrete is to be deposited on slopes, a comparatively dry mix may be used, but great care shall be exercised to spread such concrete evenly in layers not more than six (6) inches in thickness and to ram it thoroly. In general the methods used shall be such as to give a compact, dense and impervious concrete with a smooth surface.

(42) *Construction Joints.* No horizontal construction joints shall be made except at the places shown on the plans. Joints between succeeding sections of the sewer shall be made vertically. All joints shall be provided with dovetails or keyways for bonding with next section.

(43) *Joining New Work to Old.* When new work is joined to that already in place, the contact surfaces of the old concrete shall be thoroly cleaned, using a stiff wire brush, and if necessary a stream of water, and shall be clean and wet at the moment the fresh concrete is placed. A thick wash of rich mortar shall be run over the contact surface of the old concrete. When considered necessary by the engineer, the first one or two inches of the abutting concrete shall be picked off so as to remove the laitance or the old cement shall be washed off with acid or alkali and then with water to remove all traces of them.

(44) *Finish of Concrete Surfaces.* Special care shall be taken that all inside concrete surfaces shall be smooth and free from indentations or projections. All surfaces shall be free from voids, exposed stones and other imperfections. If such imperfections are found upon removing the forms, the fault shall be corrected at the contractor's expense by immediately filling with mortar or otherwise as directed.

(45) *Plastering of Concrete Surfaces.* No plastering of any concrete surface shall be done unless expressly permitted, and if so permitted shall be made in strict accordance with directions. No payment will be made for plastering done to correct defective work.

(46) *Masonry in Water.* No concrete or other masonry shall be deposited under water without permission, and then only in accordance with directions. Water shall not be permitted to rise on any masonry until it shall have set at least twelve (12) hours.

(47) *Drying Concrete.* Precautions shall be taken to prevent concrete from drying until there is no danger of cracking from lack of moisture. Concrete shall be kept moist for at least one week, unless sooner covered with earth. This may be done by a covering of wet sand, burlap, continuous sprinkling, or by other methods approved by the engineer.

(48) *Forms.* There shall be provided suitable collapsible centers or forms with smooth surfaces of ample strength and rigidly braced. The bracing shall be adequate to prevent deviations from the correct lines. All steel forms shall be neatly and accurately made with all similar parts in each longitudinal section of form interchangeable with other sections. Bent plates required to fit shall be rolled and fabricated to the correct curves before assembling. Suitable forms shall be provided for bends in the sewer. Steel filler plates shall be furnished. All wooden forms shall be built of clean, sound lumber, reasonably free from knots, dressed on all sides and neatly fitted. Tongued and grooved material shall be used where required. The form surface shall be watertight, securely fastened to the ribs or supports. No forms built up in the trench or ribs with separate pieces of wooden lagging will be allowed except for specials or curves. No center or form shall be used which is not clean and of proper shape and strength and in every way suitable. Before placing concrete or reinforcement the forms shall be coated with lubricants to prevent adherence of concrete.[14]

(49) *Removal of Arch Forms.* Arch forms shall not be slackened until the backfilling has been carried to a height of at least one (1) foot above the top of the arch and tamped. The contractor shall be responsible for all damage caused by premature removal of forms.

(50) *Backfilling.* Backfill, over and around arch sewers, shall be placed as soon as possible after concrete has set. The filling up to the plane of the top of arch shall be made from the best earth and shall not contain a sufficient amount of stones to allow the pieces to become wedged. This part of the fill shall be made in layers of not over six (6) inches and carefully tamped. If the remainder of the backfill is dumped from buckets, the contents of the buckets shall not be allowed to fall directly on the sewer, but shall be deposited on existing backfill and allowed to slide into the trench, unless the impact is broken by timber grillage. Bracing should generally be removed only when the trench below it has become substantially filled and every precaution shall be taken to prevent any large slips of earth from the side of the trench onto or against the green arch.

(51) *Reinforcement.* Steel bars of the dimensions shown for the reinforcement of concrete sewers shall be put in place as shown on plans. Bars shall be bent without beating to the shapes shown, and shall be placed in exact positions and with the spacings shown. They shall be securely fastened so as to prevent displacement during the placing of concrete. The engineer reserves the right to order the use of special fastenings in order to hold the reinforcement rigidly in place. All bars where spliced are to have a lap of at least forty (40) times their diameter.

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[14] NOTE.—Ordinary crude petroleum oil makes a satisfactory lubricant for forms and is the one most commonly used.

(52) *Construction of Inverts.* On all sections having a comparatively flat invert, the complete invert shall be built first, while on all circular sections a center strip of not less than one-fourth (¼) the circumference shall be built. The invert or center strip shall be placed in sections of not over sixteen (16) feet where the surface is to be finished with end guides and a longitudinal straight edge, and not more than twenty (20) feet where a separate lining of vitrified brick or tile is to be used.

(53) *Finish of Unlined Inverts.*[15] The concrete for the invert is to be laid in the trench as one operation, and the invert surface formed by the use of end guides and straight edges and floated and troweled to true lines and cross section. Within two (2) hours after the concrete is laid, a dry mix of two (2) parts of Portland cement and one (1) part of sand, free from crusher dust and particles larger than one-eighth (⅛) inch, shall be sprinkled over it, floated and troweled. This treatment shall be repeated at least once and as often as necessary to obtain a smooth impervious finish.

(54) *Vitrified Brick Lining.*[15] The concrete bottom shall be shaped up to a line one-half (½) inch below the bottom of the brick lining and allowed to set before brick-laying commences. Brick shall be laid by skilled brick-layers using mortar of the quality as hereinafter specified under the heading "Mortar." Brick shall be laid on edge as stretchers, to lines stretched between end guides for each three (3) courses of brick and so that end joints are broken by a lap of at least two (2) inches. Mortar joints shall not exceed one-fourth (¼) inch in thickness and shall be carefully struck as soon as each length of section is completed, and all loose mortar shall be carefully removed. No brick shall be laid loose and subsequently grouted.

(55) *Vitrified Tile Invert Lining for Inverts.*[15] Vitrified tile for lining inverts shall be of the same quality as specified for segmental blocks. They shall be not more than twelve (12) inches by eighteen (18) inches in surface area and not less than one (1) inch in thickness. The back of the tile shall be roughened and equipped with lugs or projectors for bedding the mortar. The tile shall be carefully bedded in wet mortar, the mortar bed to be approximately one-half (½) inch in thickness. Blocks shall be laid to lines stretched between end guides for each course of block to be laid. Each block must have an even bearing over its entire surface and the finished surface shall be smooth and even and conform accurately with the shape of the invert as shown on the plans.

(56) *Hydrated Lime.* Hydrated lime may be added to concrete mix at the option of the engineer, and in the amounts ordered by him. Hydrated lime so used will be estimated and paid for by the ton, which price shall include the entire cost of

[15] NOTE.—These three methods of finishing invert are given complete. Any one may be used as preferred.

furnishing, mixing and placing, and shall be in addition to the payment for concrete or concrete sewers.[16]

(57) *Payment.* Concrete shall be estimated in place and paid for by the cubic toot at the price bid, which price shall be full payment for all the cost of furnishing, mixing, placing, protecting and pointing of all concrete and of furnishing, placing and removing all centering and form work necessary.

(58) Steel bars for reinforcement will be estimated and paid for by the pound at the respective prices bid for reinforcing steel bars, which prices shall be full payment for furnishing, protecting, bending and placing all steel bars, and of furnishing and placing all wires, clips, chairs, or other devices to be used for securing the bars. Payment will be made for all laps used for splices on transverse bars as shown on the plans. On longitudinal bars the contractor will be paid for laps according to length of sections ordered put in.

(59) Invert finishing and invert lining will be estimated and paid for by the square foot at the respective prices bid, which prices shall be full payment for the finished invert or finished lining complete. These prices shall be in addition to the amount paid for concrete in place contained in the invert.

Mortar

(60) *Composition.* Mortar for brick or segmental block masonry shall be made of one (1) part portland cement and three (3) parts of sand. Mortar for pipe joints shall be made of one (1) part of portland cement and one (1) part sand. The sand and cement shall be of the quality specified in Part I, and shall be measured by volume, ninety-four (94) pounds of cement to be used as one (1) cubic foot.

(61) *Manner of Preparation.* For either class of mortar the sand and cement shall be thoroly mixed dry in proper boxes and such quantity of clean water added as will produce a stiff mortar of the proper consistency. The whole mass shall be thoroly worked with proper tools.

(62) *Hydrated Lime.* Hydrated lime may be added to the mortar mix and paid for in the manner hereinbefore specified under concrete.

Brick Masonry

(63) *Quality.* All brick masonry, whether in sewers, manholes, inlets or other structures, shall be made of brick and mortar of the quality hereinbefore specified, and laid in a careful and workmanlike manner by skilled bricklayers.

(64) *Wetting.* All common brick shall be thoroly wetted before being laid.

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[16] NOTE.—Hydrated lime may be used to advantage in increasing the workability of concrete. Published tests indicate that it slightly reduces strength.

(65) *Freezing Weather.* The provisions of the paragraph entitled "Work in Freezing Weather," under the heading "Concrete," shall apply to brick masonry.

(66) *Measurement and Payment.* All brick masonry will be measured and paid for by the cubic foot at the price bid, which price shall be full payment for masonry in place, including plaster coat where specified. Where dimensions are not shown on plans, one (1) ring will be estimated as four and one-half (4½) inches, two (2) rings or wall masonry one brick length in thickness as nine (9) inches, three (3) rings or wall masonry one and one-half (1½) brick lengths in thickness as thirteen (13) inches; four (4) rings or wall masonry two (2) brick lengths in thickness as eighteen (18) inches.

Brick Sewers

(67) *Line and Grade.* Brick sewers shall be constructed of the form and dimensions indicated on the plans and shall be built to the lines and grades given by the engineer.

(68) *Laying Brick.* Brick shall be laid by placing sufficient mortar on the bed and forcing the brick into it at one operation. All bricks in each course shall be stretchers and shall break joints with those in adjoining courses, except at spring line, where corners may be bonded with headers. No brick shall be laid loose and subsequently grouted.

(69) *Racking Courses.* All unfinished brick work must be racked back in courses and the mortar removed from the exposed surface of the bricks before it has had time to harden. When new work is joined to old, the surface of the bricks where joints are to be made must be washed and cleaned.

(70) *Brick Laterals.* When two brick sewers intersect, the junction shall be constructed as a plain intersection of the two barrels and no bell-mouth arch built unless specifically shown on the plans. Great care shall be taken to obtain first-class brick work on the two arches near the intersection and to trowel the inside surface wherever clipped brick have been used.

(71) *Pipe Laterals and Slants.* Pipe laterals and slants shall be built into the brickwork wherever shown on the plans or designated by the engineer. In all cases the laterals shall enter the sewer at an angle of at least forty-five (45) degrees. Where slants cannot be used, the pipe shall be neatly clipped to conform to the inside face of the sewer and the edges neatly plastered with cement mortar. In no case will jagged edges be allowed to project into the barrel of the sewer.

(72) *Payment.* Brick masonry will be estimated and paid for as specified in the paragraph styled "Measurement and Payment" under the heading "Brick Masonry," no deductions being made for manhole openings or gaps in the wall for junctions and slants.

Construction of Inverts of Brick Sewers

(73) *Profiles.* In building inverts, a profile of the same dimensions as the brickwork shall be securely fixed at the forward end of the section and a line stretched between nails spaced around its inner surface and corresponding points on the completed invert for every three (3) courses.

(74) *Joints.* The mortar joints on the inside ring shall not exceed one-fourth (¼) inch in thickness. In the outer ring, a thickness of one-fourth (¼) to one-half (½) inch will be permitted.

(75) *Striking Joints and Cleaning.* All joints on the inside of the sewer shall be carefully struck as soon as the section of invert is completed and the loose mortar removed from the sewer.

(76) *Water in Trench.* Water which may collect in the trench ahead of the completed invert shall not be bailed up and thrown on the brickwork nor allowed to overflow onto it until at least eight (8) hours after laying.

Construction of Arches of Brick Sewers

(77) *Centers.* The arch shall be built on strongly built centers, the working face of which shall be of the same dimensions as the arch to be constructed. The lagging shall be planed on one face and two edges, laid on the templates in a tight and workmanlike manner.

(78) *Cleaning at Spring Line.* Before the centers are placed, all earth or loose mortar shall be carefully scraped from the spring line of the completed invert, and if at any time before the arch is started, loose material falls from the side walls, it shall be thoroly cleaned off before brick are laid.

(79) *Joints.* Where centers are to be pulled while the mortar is still green, the longitudinal joints shall be made as thin as it is practicable to make a full joint, and in no case greater than one-fourth (¼) inch in thickness.

(80) *Plastering.* The exterior surface of the arch shall be covered with a coating of mortar not less than three-eighths (⅜) inch thick.

(81) *Drawing Centers.* When a section of arch is completed, the entire space between the curved masonry surface and the sides of the trench shall be filled with earth placed in six (6) inch layers, each thoroly rammed to a height level with the extrados of the brick arch. When this has been done to the satisfaction of the engineer and when the spring line of the invert ahead has been cleaned as provided in the paragraph styled "Cleaning at Spring Line," the center may be loosened and drawn ahead. They shall be scraped clean immediately upon drawing.

(82) *Striking Joints and Cleaning.* As soon as the center has been drawn and before brick-laying is recommenced, the inside joints of the arch just completed shall be carefully rubbed full and struck to give a smooth interior surface, and the loose mortar from this work together with any other rubbish immediately removed from the sewer.

Segmental Block Sewers

(83) *Line and Grade.* Segmental block sewers shall be constructed of the form and dimensions shown and shall be built to the line and grade given by the engineer.[17]

(84) *Joints.* Segmental blocks shall be laid so that all joints are staggered, using short blocks where necessary. Care shall be taken that all joints are filled with mortar, those on the inside of the sewer not to exceed one-fourth (¼) inch in thickness. On the two-ring blocks the joints between the inner and outer rings shall be formed by placing the last ring to be laid on a bed of mortar spread on the ring in place, and tamping or squeezing the block into place. In order to insure that all space between blocks is filled, it will be necessary to spread an excess amount of mortar, the excess being squeezed out as the block is pushed into place. With one-ring blocks the same procedure shall be taken in closing the ship-lap joint between blocks. With either kind of block the blocks shall be so bedded that there are no offsets between blocks, and that the inside face of the sewer shall present a smooth straight surface.

(85) *New and Old Work.* When joining new work to that already in place, the surface of the block where joints are to be made must be washed and cleaned.

(86) *Mortar.* Mortar for segmental block sewers shall be of the quality as specified under the heading "Mortar."

(87) *Junctions.* "T" or "Y" Junctions shall be installed as shown on plans or as designated by the engineer, and when not to be immediately used shall be closed with earthenware covers held lightly in place by mortar. Payment will be made at the price bid, which shall be in addition to the payment for sewers to which these specials are attached, and shall include the cost of covers.

(88) *Reducers.* Gradual reducers of a length of at least ten (10) feet shall be built wherever the size is changed. These reducers shall be built of brick masonry or concrete, according to the specifications for those classes of sewers, and will be paid for according to the prices bid for the items used.

(89) *Measurement and Payment.* Segmental block sewers will be paid for by the linear foot of completed sewer and the

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[17] NOTE.—Segmental tile is a comparatively new material for sewer construction. It can usually be used to advantage in competition with other sewer materials. Several types are available. The engineer considering the use of this material should carefully investigate its applicability to the particular conditions as well as the various types, their safe bearing load and facility for construction as compared to other standard materials.

length of the particular size to be paid for shall be the actual invert length of that size laid, which price shall be full payment for segmental block sewers in place complete. On two-ring work, where the outer ring is omitted in the invert, the sewer will be paid for at three-fourths (¾) the price bid for full section.

Construction of Inverts of Segmental Block Sewers

(90) *Templets.* In building inverts a templet of the same dimensions as the section of the sewer shall be securely fixed at the forward end of the section and a line stretched between rails spaced around its inner surface and corresponding points on the completed invert for each course of block to be laid.

(91) *Bearing.* In laying the outer ring of the invert, care shall be taken to obtain a solid and even bearing for each block and concrete or mortar used when necessary to smooth up the bed.

(92) *Inverts in Rock.* On two-ring work, where solid rock is encountered in the invert, the outer block may be omitted and the inner block with mortar and concrete backing used. The Class "C" concrete backing shall be accurately brought to a line two and one-half (2½) inches from the inside face of the block. Mortar of the proper consistency shall then be spread on this concrete backing and the block brought to line by pressing it into the mortar bed.

(93) *Striking Joints and Cleaning.* All joints on the inside of the sewer shall be rubbed full and jointed as soon as a section of the invert is completed and all loose mortar shall be removed from the sewer.

(94) *Water in Trench.* Water which may collect in the trench ahead of the completed invert shall not be bailed up and thrown on the completed invert nor allowed to overflow onto it until at least eight (8) hours after laying.

Construction of Arches of Segmental Block Sewers

(95) The provisions of the paragraphs titled "Centers," "Cleaning at Spring Line," "Drawing Centers," and "Striking Joints and Cleaning" under the heading "Construction of Arches of Brick Sewers" shall apply similarly to the construction of arches of segmental block sewers.[18]

(96) *Exterior Joints.* The exterior joints of the arch shall be filled with mortar before any backfilling is done.

Pipe Sewers

(97) *Grade.* The grade as shown on the profile is that of the inner side of the invert and to which the work must conform. A variation of one-half (½) inch from this will be deemed sufficient reason to cause the work to be rejected and rebuilt. The engineer will set all stakes for lines and grades which the

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[18] NOTE.—For loadings which might exceed the strength of segmental block arches, the strength can be materially and cheaply increased by partially filling the haunch with concrete instead of earth.

contractor must maintain and keep uncovered, so that they can be examined at any time. The grade shall be kept by line or ranging rods as the engineer shall direct. Such ranging rods, poles, levels, straight edges, etc., as are required for the work will be furnished by the contractor.

(98) *Shaping Trench Bottom.* The bottom of the trench shall be shaped so as to conform as nearly as possible to the outside of the pipe, particular care being taken to recess the bottom of the trench in such a manner as to relieve the bell of all load. In rock the excess excavation shall be refilled to subgrade with three-fourths (¾) inch gravel or Class "D" concrete, thoroly tamped and shaped to fit the bottom of the pipe so that at least the lower third of the pipe is evenly supported thruout its entire length. Gravel or Class "D" concrete used for this purpose will be paid for at the prices bid, the amount to be paid for being the same as the amount of Class "A" excavation below subgrade.

(99) *Laying.* Each pipe shall be laid to the line and grade given by the engineer and in such a manner as to form a close concentric joint with the adjoining pipe and prevent sudden offsets of flow line. All pipes shall be laid with bells uphill. The subgrade must be kept free from water while pipe are being laid. Joints shall be made in the manner specified in the following two paragraphs.

(100) *Cement Joints.* A closely twisted hemp or oakum gasket of such diameter as required to support the spigot of the pipe at the proper flow line grade and make truly concentric joints, and in one piece of sufficient length to pass around the pipe and lap at the top, shall be thoroly saturated in cement mortar. This gasket shall be laid in the bell for the lower third of the circumference of the joint and covered with mortar specified for pipe joining. The spigot of the pipe shall then be inserted and carefully driven home, after which a small amount of mortar shall be inserted in the annular space around the entire circumference of the pipe. The ends of the gasket shall then be wrapped around the pipe and solidly rammed into the joint with a calking tool, the mortar previously placed being driven ahead of the gasket. The remainder of the joint shall then be completely filled with mortar and beveled off to an angle of forty-five (45) degrees with the outside of the pipe. On pipes of eighteen (18) inches or larger in diameter, the joints shall be pointed and smoothed from the inside.

(101) *Hot Poured Joints.* Joints shall be carefully centered and calked as specified in the preceding paragraph. A suitable runner then shall be placed and the compound, heated to a temperature of approximately four hundred (400) degrees F., shall be poured into it in such a manner that the annular space shall be completely filled. When bituminous joints are used it will be permissible to make alternate joints before lowering pipe into trenches.[19]

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[19] NOTE.—For combined sewers and sanitary sewers in dry ground, cement joints are considered satisfactory. For sanitary sewers below the ground water-table bituminous joints are preferred. The use of a concrete cradle in the latter case may sometimes be advisable.

(102) *Cleaning.* The interior of the sewer shall, as the work progresses, be cleared of all dirt, cement and superfluous materials of every description. On small sewers, where cleaning after laying may be difficult, a swab or drag shall be kept in the pipe line and pulled forward past each joint immediately after its completion.

(103) *Backfilling.* Before the usual backfilling is commenced, fine earth shall be tamped around and above the pipe to a depth of one (1) foot above the extrados. No walking over the pipe will be allowed until one (1) foot of backfill is complete. Care shall be taken to prevent any disturbance to the pipe or damage to newly made joints.

(104) *Junctions.* "T" or "Y" Junctions shall be installed at the places shown on plans or designated by the engineer, and when not to be immediately used shall be closed with earthenware covers held lightly in place by mortar. Payment will be made at the price bid, which shall be in addition to amount paid per linear foot of sewer, and shall include the cost of covers.

(105) *Measurement and Payment.* Pipe sewers will be paid for by the linear foot of completed sewer, the length of the particular size to be paid for shall be the actual length of that size laid. This price shall be full payment for furnishing pipe and joining materials and incorporating them into a completed sewer as specified above.

Manholes and Inlets

(106) *Materials.* Manholes and inlets may be built of either concrete or brick masonry.

(107) *Concrete.* Concrete manholes and inlets are to be constructed of Class "A" concrete, using tight smooth forms, and shall be of the same quality of workmanship and materials as specified under "Concrete" and "Concrete Sewers."

(108) *Brick.* Brick manholes and inlets shall be built of brick masonry of the quality as specified under "Brick Masonry." Every fifth course of brick shall be laid as stretchers, the remainder being laid as headers. Every brick shall have full mortar joints on the bottom and sides, which shall be formed at one operation by placing sufficient mortar on the bed and forcing the brick into it. Horizontal joints shall not exceed three-eighths (3/8) inch, and the vertical joints on the inside of the manholes shall not exceed one-fourth (1/4) inch. Joints on the inside face are to be carefully rubbed full and struck as the manhole is built up. A single rowlock shall be turned over all incoming and outgoing pipes.

(109) *Steps.* During the construction of each manhole, steps of wrought iron or cast iron, shall be set in place on the inside of the manhole, beginning two (2) feet above the bottom and placed not more than eighteen (18) inches apart. These steps

are to be built of the dimensions shown on the plans and shall be firmly built in the wall, allowing them to project three and one-half (3½) inches from the inside of the manhole.

(110) *Frames and Covers.* When the manhole or inlet masonry is completed, frames or covers of the dimensions and materials as shown on the plans are to be set in place to the line and grade given by the engineer.

(111) *Payment.* Masonry in manholes and inlets will be estimated to the dimensions shown on the plans and paid for at the price bid per cubic foot for masonry of the class used. Frames and covers will be paid for by the piece at the price bid. In all cases the amount paid shall be full payment for all work in place complete.

GENERAL STIPULATIONS

It is further expressly agreed between parties hereto that this contract is made subject to the conditions and stipulations which follow:

1st. *No Assignment.* No assignment of the work shall be made or recognized; but the contractor will be held responsible for the work until its final completion.

2nd. *Prosecution of Work.* The contractor shall commence the work at such points as the engineer may direct and conform to his direction as to the order of time in which the different parts of the work shall be done, and to all his instructions as to workmanship, character of work and quality of material so as to accomplish the object of this contract in strict accordance with all its terms and in the time specified, but not so to affect the contractor's method and manner of constructing the work in its details.

3rd. *Employes of Contractor.* The contractor must at all times have an authorized representative on the work to whom orders can be given, this representative to have full authority to carry out all orders given by the engineer. If any person employed on the work shall refuse or neglect to obey the directions of the engineer, or his duly authorized agents, as to workmanship, character of the work and quality of materials, or shall appear to the engineer to be so incompetent, disorderly or unfaithful as to endanger the proper fulfillment of this contract, he shall, upon the request of said engineer, be at once discharged and not again employed on any part of the work.

4th. *Decision of Disputed Questions.* To prevent all disputes and litigations, it is further agreed by all parties hereto, that the engineer shall in all cases determine the amount or quantity, or the classification of the several kinds of work or materials which are to be paid for under this agreement, and he shall decide all questions which may arise relative to the execution of this agreement.

5th. *Arbitration.* If the contractor believes that a decision of the engineer is unfair and is likely to entail on him unjustly great financial loss, he has the right to have the disputed matter referred to a "Board of Arbitration," composed of two or three disinterested persons, one to be appointed by the city, another by the contractor, and the third, if required, to be chosen by the first two. Any decision arrived at by the first two and agreed upon in writing shall be binding upon both parties. The expense of the first two arbitrators shall be borne by their respective principals, the expense of the third to be equally divided between the principals.

6th. *Changes in Plans.* The engineer shall have the right to make alterations in the line, grade, plan, form or dimensions of the work herein contemplated, either before or after the commencement of the work. If such alterations diminish the quantity of work to be done they shall not constitute a claim for damages for anticipated profits for the work dispensed with; if they increase the amount of work the increase shall be paid according to the quality of work actually done and at the price established for such work under this contract excepting where, in the opinion of the engineer, the contractor is clearly entitled to extra compensation.

7th. *Defective Work.* The contractor shall remove, rebuild and make good at his own cost any work which is found to be defectively executed, and omission to condemn work at the time of its construction shall not be construed as an acceptance of defective work. If any doubt exists as to the character of defective work, it must, at the request of the engineer, be taken up. If found to be imperfect, it must be made good, and if satisfactory, the actual cost, plus fifteen (15) per cent, of taking up and replacing, will be paid to the contractor.

8th. *Observance of Ordinances and Laws.* The contractor will be required to observe all city ordinances in relation to obstructing streets, maintaining signals, storing and handling of explosives, etc., and all general ordinances and state statutes affecting him or his employes or his work hereunder in his relations to the city of ————, or any other person, and also obey all laws or ordinances controlling or limiting the contractor while engaged in the prosecution of work under this contract.

9th. *Indemnity to City.* The contractor herein binds himself to indemnify and save harmless the city of ———— from all suits and action of every name and description brought against said city, for or on account of any injury or damages received or sustained by any party or parties by or from the acts of said contractor, or his servants or agents, in doing the work herein contracted for, or by or in consequence of any negligence in guarding the same, or on account of any improper materials being used in construction, or by or on account of any act or omission of the said contractor or his servants or agents.

10th. *Time of Beginning and Completion.* Construction work must begin within —— days after written notice to do so shall have been given to the contractor by the engineer and shall be carried on regularly and uninterruptedly thereafter at a rate to secure its full completion within —— days thereafter, unless the time shall have been extended as provided in Paragraph Eleven (11) of these stipulations and then within said period plus the additional time allowed, the time of beginning, rate of progress and time of completion being essential conditions of this agreement. If the contractor fails to complete the work within the time above specified, an amount sufficient to compensate the engineers and inspectors for their services for the extra period necessary to complete this contract shall be deducted from sums due the contractor.

11th. *Delays.* The contractor shall not be entitled to any claim for damages for any delays, unless such delay is clearly due to the fault or neglect of the city and then only to the exact cost without profit to him of such delay. Delays or hindrances may entitle the contractor to an extension of the time for completing the work sufficient to compensate for the detention, the same to be determined by the engineer, provided he shall have immediate notice in writing of the cause of such delay.

12th. *Procedure in Taking Work from Contractor.* In case of unnecessary or inexcusable delay in the general conduct of the work or in the event of an actual or practical abandonment of the work, the engineer will notify the contractor and his bondsmen in writing to that effect. If the contractor or his bondsmen shall not within six (6) consecutive days thereafter take such measures as will, in the judgment of the engineer, insure the satisfactory completion of the work in the time specified, the engineer may then by and with the consent of the city, notify the aforesaid contractor and his bondsmen to discontinue all work under this contract, and it is hereby agreed that the contractor and his bondsmen shall immediately respect said notice and stop work, and cease to have any right to possession of the ground. The engineer shall thereupon have the power, under the direction of the city of ————, to place such and so many persons and equipment as he may deem advisable by contract or otherwise, to complete the work herein described, and to use such materials as he may find upon the line of said work, and to procure other materials for the completion of same. All expense of such completion of the work, including the additional payment to be made to the persons completing the same, and any other claim arising under this contract, shall be deducted and paid by the parties of the second part out of such moneys as may then be due the said contractor, or which may thereafter become due under and by virtue of this agreement or any part thereof. In case such expense is less than the sum which would have been payable for such work under this contract, if the same had been completed by the parties of the first part, the contractor shall be entitled to receive the difference; if the expense is greater, the bondsmen will be called on to make up the difference.

13th. *Extra Work.* No claim for extras shall be allowed in favor of the contractor unless such extras have been ordered in advance in writing by the engineer, and all claims for extras so ordered shall be submitted to him and the reasonable value of such extras shall be determined by him and his decision thereof shall be final and conclusive, and the allowance made by him on account of such extras shall be added to the final estimate.

14th. *Work to be Kept in Repair.* The contractor hereby agrees to keep such work as may be done by him under this contract, in complete repair for twelve (12) months after its final acceptance and authorizes the said city to retain five (5) per cent of the gross amount of this contract for the same period to insure such repairs. In case of failure on the part of the contractor to perform this portion of the contract, such repairs will be made by the city and expenses thereof deducted from the percentage retained.

15th. *Basis of Payment.* In consideration of the completion by the contractor, party of the first part, of all work embraced in this agreement in conformity with the specifications and stipulations herein contained, the city of ————, party of the second part, hereby agrees to pay said party of the first part the following prices:

Class "A" excavation, per cubic yard.................Dollars
Class "B" excavation per cubic yard.................Dollars
Class "C" excavation, per cubic yard.................Dollars
Excavation below grade, per cubic yard...............Dollars
Refilling below grade, per cubic yard.................Dollars
Removing and replacing pavements per square foot......Dollars
Piling, per linear foot...............................Dollars
Lumber for caps and framing, per thousand feet,
B. M..Dollars
Lumber left in trench, per thousand feet, B. M..........Dollars
Temporary bridges, per square foot....................Dollars
Gravel or broken stone, per cubic foot................Dollars
Class (———) concrete, per cubic foot................Dollars
Boulders, per cubic foot..............................Dollars
Common brick masonry, per cubic foot...............Dollars
Vitrified brick masonry, per cubic foot................Dollars
Hydrated lime, per ton................................Dollars
Reinforcing steel bars, (———) inches square, per
pound...Dollars
Concrete invert finishing or lining, per square foot.......Dollars
One-ring segmental block sewer, (———) inches in
diameter, per linear foot..........................Dollars
Two-ring segmental block sewer, (———) inches in
diameter, per linear foot..........................Dollars

Vitrified sewer pipe, (———) inches in diameter per linear foot....................................Dollars
Cement concrete pipe, (———) inches in diameter, per linear foot....................................Dollars
Reinforced concrete pipe, (———) inches in diameter, per linear foot....................................Dollars
(———)-inch pipe underdrains, per linear foot..........Dollars
(———)-inch pipe slants, per piece....................Dollars
(———)-inch "Y" or "T" junctions on segmental block sewer, per piece..........................Dollars
(———)-inch "Y" or "T" junctions on (———)-inch pipe, (———) inches in diameter, per piece.....Dollars
Manhole steps, per piece..........................Dollars
Manhole frames and covers per piece................Dollars
Inlet or catch basin covers, per piece................Dollars

16th. *Monthly Estimates.* About the first of each month, the engineer will estimate approximately the amount of work completed during the preceding month and the relative value thereof at the prices hereinbefore named. Eighty-five (85) per cent of this amount shall then be due and paid the contractor, except as provided for elsewhere, on or before the fifteenth (15th) day of each month for the work of the preceding month.

17th. *Final Estimate.* When all the work embraced in this contract is fully completed agreeably to the specifications and stipulations of this agreement, and accepted by the engineer, said engineer shall make a final estimate of the amount and value of said work according to the terms and prices of this agreement. Said estimate shall be submitted to the city, and said city shall, except for cause herein specified, pay to the contractor within fifteen (15) days thereafter the balance due, excepting therefrom such sums as may be lawfully retained under any of the provisions of this contract. Provided, that if the contractor shall fail to pay the laborers employed on the work or to pay for materials used therein, the city may withhold from paying the contractor everything in excess of eighty-five (85) per cent of the value of the work done, until they shall be satisfied that all such claims for labor or materials are paid.

The said ....

....

as Principal, and ....

....

as Surety, hereby bind themselves and their respective heirs, executors or administrators, successors or assigns, unto the said City of ....in the penal sum of ....
....Dollars
lawful money of the United States, conditioned that in the event the said ....

....

shall faithfully and properly perform the foregoing contract, according to all of the terms thereof, and shall as soon as the work contemplated by said contract shall have been completed, pay the proper parties all amounts due for material and labor used and employed in the performance thereof, then this obligation to be void, otherwise of full force and effect; and the same may be sued on at the instance of any material man, laboring man or mechanic in the name of the city of ———— to the use of such material man, laboring man or mechanic for any breach of the conditions thereof.

IN WITNESS WHEREOF, the said....................
....................................as Principal,...
and..
....
as Surety, parties of the first part, have hereunto set their hands and seals respectively, and the City of ...., party of the second part, acting by and through the......................
aforesaid has subscribed these presents the day and year first above written.

..............................(SEAL)
..............................(SEAL)
..............................(SEAL)
..............................(SEAL)

The City of..........................
By ....

PROPOSED CONTRACT AND SPECIFICATIONS FOR CONSTRUCTING SEWERS

(*Alternate form; Payments by Linear Foot*)

NOTE: The specifications being the same as those above except as to manner of payment, only the sections that differ are given below.

Approximate Quantities

Class "A" excavation............................cubic yards
Class "B" excavation............................cubic yards
Excavation below grade..........................cubic yards
Removing and replacing pavements..............square feet
Reinforced concrete sewers, (———) inside dimensions,
 classified as follows:
 (0–6)
 (6–8) feet deep................................linear feet
 (etc.)
Plain concrete sewers, (———), inside dimensions,
 classified as follows:
 (0–6)
 (6–8) feet deep................................linear feet
 (etc.)
Brick sewers, (———), inside diameter, classified
 as follows:
 (0–6)
 (6–8) feet deep................................linear feet
 (etc.)

One-ring segmental block sewers (———) inside diameter classified as follows:
(0–6)
(6–8) feet deep . . . . linear feet
(etc.)
Two-ring segmental block sewers (———) inside diameter, classified as follows:
(0–6)
(6–8) feet deep . . . . linear feet
(etc.)
Vitrified sewer pipe, (———) inside diameter, classified as follows:
(0–6)
(6–8) feet deep . . . . linear feet
(etc.)
Cement concrete pipe, (———), inside diameter, classified as follows:
(0–6)
(6–8) feet deep . . . . linear feet
(etc.)
Reinforced concrete pipe, (———) inside diameter, classified as follows:
(0–6)
(6–8) feet deep . . . . linear feet
(etc.)
Manholes, (———) inside dimensions, classified as follows:
(0–6) feet deep . . . . number
Additional depth of manholes . . . . linear feet
Inlets, (———) inside dimensions, classified as follows:
(0–4) feet deep . . . . number
Additional depth inlets . . . . linear feet
Underdrains, (———) inches in diameter . . . . linear feet
Refilling below grade . . . . cubic yard
Class "C" concrete . . . . cubic feet
Piling . . . . linear feet
Lumber for caps and framing . . . . "M" ft. B. M.
Lumber left in trench . . . . "M" ft. B. M.
Temporary bridges . . . . square feet
(———)-inch pipe slants . . . . pieces
(———)-inch "Y" or "T" junctions on segmental block sewers . . . . pieces
(———)-inch "Y" or "T" junctions on (———) pipe . . . . pieces
Hydrated lime . . . . tons

DIVISION OF SPECIFICATIONS

Part I.—Materials.
Part II.—Methods of Construction.

PART I. MATERIALS

Sections 1–62, inclusive, are same as in specifications above.

PART II. METHODS OF CONSTRUCTION

Excavation

(1) *Included Work.* Subject to the provisions of following paragraphs covering Class "A" and Class "B" Excavation, the prices named under all items for, or requiring excavation, are to include the work of removing all obstructions on the surface of streets, alleys, rights-of-way and public places; of making all necessary excavation; of furnishing and putting in place all shoring and bracing necessary to excavate and protect the work; of doing all pumping and bailing necessary to keep the trenches free from water; of providing for the uninterrupted flow of sewers and surface water, and the temporary disposal of water from all other sources during the progress of the work; of protecting all pipes, conduits, street car and railroad tracks, poles, wires, fences, buildings, and other public and private property along the field of operation; of removing after completion of the work all shoring and bracing not necessary to support the sides of the trenches; of hauling away all surplus excavation and material; of doing all backfilling; of restoring all property, injury to which is contemplated in this contract; and of restoring all surfaces and curbing of streets, alleys and rights-of-way to as good condition as they were prior to the beginning of excavation, excepting where such work is included under the item "Removing and Replacing Pavements."

(2) *Class "A" Excavation Defined.* Class "A" excavation shall comprise solid rock in the original bed or well defined ledges, and which can only be removed by continuous blasting; and all boulders or detached pieces of rock eight (8) cubic feet or more in content.[1]

(3) *Class "B" Excavation Defined.* Class "B" excavation shall comprise all shale, soapstone, slate, hard-pan, fire clay, cemented gravel, macadam or telford pavements, brick masonry, except in pavements, and detached pieces of rock less than eight (8) cubic feet or more than one (1) cubic foot in content.

(4) *Payment for Class "A" and Class "B" Excavation.* Payment for Class "A" and Class "B" Excavation shall be made at the respective prices bid per cubic yard, which prices shall be in addition to the amounts paid per linear foot of completed sewer.

(5) *Open Cut and Tunnels.* In general, excavation shall be made in open cut from the surface and the contractor shall not be allowed to do any tunneling without obtaining permission from the engineer, and then only according to methods approved by him. This permission will only be given where a line is to be

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[1] NOTE.—In localities where limestone, which might vary by imperceptible degrees from shales and other stones, occurs, the Chicago definition of rock is considered valuable. "Rock shall mean any material geologically in place, cemented into a mass by natural causes and of hardness, when first exposed, of three (3) (the hardness of transparent calcite) or greater in the scale of mineral hardness. Frozen material shall not be classified as rock."

laid behind the curb, across a paved street, under street car or railroad tracks, or where, in the opinion of the engineer, it is necessary to tunnel short sections on account of proximity of adjacent walls or structures. Such excavation then can be made in alternate sections of open cut and tunnel, the length of the tunnel sections to be specified by the engineer and the head room in them to be not less than three (3) feet measured from the top of the sewer. These tunnel sections shall be cut underneath to a wedge with its edge horizontally across the sewer and backfilled tightly by tamping from each end.[2]

(6) *Class "A" and Class "B" Excavation Above Spring Line of Sewers Built in Place.* Class "A" and Class "B" excavation above spring line of sewers built in place, will be estimated and paid for as a trench with vertical sides, the distance between which shall be one (1) foot greater than the outside horizontal dimension of the masonry at the spring line.[3]

(7) *Class "B" Excavation Below Spring Line of Sewers Built in Place.* Class "B" excavation below spring line of sewers built in place shall be taken out and will be computed to the shape and outside dimensions of the masonry except in cases of special sections where the width of masonry is greater below than at spring line. In this case the trench line described in the preceding paragraph shall apply until it coincides with the outside of the masonry.

(8) *Class "A" Excavation and Concrete Refill Below Spring Line of Sewers Built in Place.* Class "A" excavation below spring line of sewers built in place shall be made so as to conform as nearly as possible to the outside shape of the sewer wall, and a smooth bed made for the masonry by filling the uneven surface of the rock with Class "C" concrete or rubble masonry, this refill being carried up to the spring line whether above the rock surface or not. With monolithic concrete sewers, concrete of the same class as the sewer walls may, at the option of the engineer, be substituted for the Class "C" in the concrete refill. The amount of Class "A" excavation to be paid for below the spring line will be the area of a segment of a circle with its chord at the surface of the rock and a radius four and one-half (4½) inches larger than the radius of the outside of the sewer section. The amount of the concrete refill to be paid for will be the difference in area of two semicircles whose radii are respectively equal to and four and one-half (4½) inches greater than the outside of the sewer section. The outside of the sewer section for the monolithic concrete section shall be considered as the outside of a regular concrete section; of the brick sewer as the

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[2] NOTE.—The above paragraph is only intended for short, isolated tunnels and should not be used for a regular tunneling specification. It was not considered feasible to write a general tunnel specification because of the large variation of local practice and of materials encountered. In localities where tunnel practice has not been well developed, it is recommended that experts in tunneling be retained to advise in the preparation of tunnel plans and specifications.

[3] NOTE.—For firm soils not requiring bracing or for rock easily shot to line, the width may be made equal to width of masonry. For sections of irregular shape, pay lines should be shown on the plans.

outside of a one-ring brick sewer; of the one-ring segmental block as the outside of a full block section; and of the two-ring segmental block as a semicircle having a radius two and one-half (2½) inches larger than the inside radius of the sewer, the outer block being omitted in the latter type of sewer and the excess space filled with mortar.[4]

(9) *Class "B" Excavation for Vitrified and Premolded Pipe.* Class "B" excavation, for vitrified tile and premolded concrete or cement pipe, will be estimated and paid for as a trench with vertical sides, a length equal to the distance from c to c of manholes, and a width twelve (12) inches greater than the inside diameter of the pipe for pipe up to and including eighteen (18) inches; fifteen (15) inches greater than inside diameter for pipe twenty-one (21) to twenty-seven (27) inclusive, and eighteen (18) inches greater than inside diameter for pipe thirty (30) inches or larger provided that no trench shall have a width of less than thirty (30) inches. The depth of trench shall include the thickness of the pipe. Where rock is encountered in the trench, the width for Class "B" overlying excavation shall be the same as in the following paragraph.

(10) *Class "A" Excavation for Vitrified and Premolded Pipe.* Class "A" excavation for vitrified tile and premolded concrete or cement pipe will be estimated as described in the preceding paragraph, except that the width and depth of trenches in rock excavation shall be increased four (4) inches.

(54) *Payment.* Concrete sewers will be paid for by the linear foot of completed sewer, this price to include all labor and material and all ordinary excavation necessary to build the sewer in accordance with the plans and specifications. In making the classification, the depth of the sewer shall be taken as the distance from the surface of the ground to the invert.

Sections 55-60 of these specifications are the same as sections 60-65 of the preceding set of specifications.

Sections 61-65 of these specifications are the same as sections 67-71 of the preceding set of specifications.

(66) *Payment.* Brick sewers will be paid for by the linear foot of completed sewer, which price shall include all labor and material and all ordinary earth excavation necessary to build the sewer in accordance with the plans and specifications. In making the classifications the depth of the sewer shall be taken as the distance from the surface of the ground to the invert, the length as the distance from center to center of manholes.

Sections 67–82 of these specifications are the same as sections 73-88 of the preceding set of specifications.

(83) *Payment.* Segmental block sewers will be paid for by the linear foot of completed sewer, which price shall include all

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[4] NOTE.—For shapes of inverts other than circular pay lines for excavation should be shown or plans.

labor and material and all ordinary earth excavation necessary to build the sewer in accordance with the plans and specifications. In making the classification the depth of the sewer shall be taken as the distance from the surface of the ground to the invert, the length as the distance from center to center of manholes.

Sections 84–91 of these specifications are the same as Sections 90–97 of the preceding set of specifications.

(92) *Shaping Trench Bottom.* The bottom of the trench shall be shaped so as to conform as nearly as possible to the outside of the pipe, particularly care being taken to recess the bottom of the trench in such a manner as to relieve the bell of all load. In rock the excess excavation shall be refilled to subgrade with three-fourths (¾) inch gravel or Class "D" concrete thoroly tamped and shaped to fit the bottom of the pipe so that at least the lower third of the pipe is evenly supported thruout its entire length. The cost of material for refilling shall be included in the price bid per linear foot of sewer.

Sections 93–97 of these specifications are the same as sections 99–105 of the preceding set of specifications.

(99) *Payment.* Pipe sewers will be paid for by the linear foot of completed sewer, which price shall include all labor and materials and all ordinary earth excavation necessary to build the sewer in accordance with the plans and specifications. In making the classification the depth of the sewer shall be taken as the distance from the surface of the ground to the invert, the length as the distance from center to center of manholes.

Sections 100–104 of these specifications are the same as sections 106-110 of the preceding set of specifications.

(105) *Payment.* Manholes and inlets will be paid for at a lump sum price for each manhole complete, including ordinary earth excavation, covers, steps and masonry. In making the classification the depth of the manhole shall be taken as the distance from the surface of the ground to the flow line grade of the manhole.

General Stipulations

Sections 1–14 of these specifications are the same as sections 1-14 of the preceding set of specifications.

15th. *Basis of Payment.* In consideration of the completion by the contractor, party of the first part, of all work embraced in this agreement in conformity with the specifications and stipulations herein contained, the city ————, party of the second part, hereby agrees to pay said party of the first part the following prices:

Class "A" excavation, per cubic yard .... Dollars
Class "B" excavation, per cubic yard .... Dollars
Excavation below grade, per cubic yard .... Dollars

Removing and replacing pavements, per square foot..... Dollars

Reinforced concrete sewers, (———) inside dimensions, classified as follows:
(0–6)
(6–8) feet deep, per linear foot.................... Dollars
(etc.)

Plain concrete sewers, (———), inside dimensions, classified as follows:
(0–6)
(6–8) feet deep, per linear foot.................... Dollars
(etc.)

Brick sewers, (———), inside diameter, classified as follows:
(0–6)
(6–8) feet deep, per linear foot.................... Dollars
(etc.)

One-ring segmental block sewers, (———) inside diameter, classified as follows:
(0–6)
(6–8) feet deep, per linear foot.................... Dollars
(etc.)

Two-ring segmental block sewers, (———) inside diameter, classified as follows:
(0–6)
(6–8) feet deep, per linear foot.................... Dollars
(etc.)

Vitrified sewer pipe, (———) inside diameter, classified as follows:
(0–6)
(6–8) feet deep, per linear foot.................... Dollars
(etc.)

Cement concrete pipe, (———) inside diameter, classified as follows:
(0–6)
(6–8) feet deep, per linear foot.................... Dollars
(etc.)

Reinforced concrete, (———) inside diameter, classified as follows:
(0–6)
(6–8) feet deep, per linear foot.................... Dollars
(etc.)

Manholes, (———) inside dimensions, (0–6) feet deep, (———) number........................... Dollars

Additional depth of manholes, per linear foot............ Dollars

Inlets, (———) inside dimensions, (0–4) feet deep, (———) number................................ Dollars

Additional depth inlets, per linear foot.................. Dollars

Underdrains, (———) inches in diameter, per linear foot.. Dollars

Refilling below grade, per cubic yard.................. Dollars

Class "C" concrete, per cubic foot....................Dollars
Piling, per linear foot..............................Dollars
Lumber for caps and framing, per thousand feet, B. M....................................Dollars
Lumber left in trench, per thousand feet, B. M..........Dollars
Temporary bridges, per square foot....................Dollars
(———)-inch pipe slants, per piece.....................Dollars
(———)-inch "Y" or "T" junctions on segmental block sewers, per piece............................Dollars
(———)-inch "Y" or "T" junctions on (———) pipe, per piece.................................Dollars
Hydrated lime, per ton..............................Dollars

Sections 16 and 17 and the contractors' bond in these specifications are the same as in the preceding set of specifications.

MINORITY REPORT

E. S. Dorr, Member of Committee

I dissent absolutely from the majority of the committee on the wording and intent of the paragraph defining Class A Excavation, I refuse to subscribe to it and propose the following as a substitute therefor—

"Class A excavation shall comprise only solid rock, such as may be approved in advance by the Engineer as requiring blasting for its removal, and boulders of three (3) cubic yards, or more each in content."

The intent of the above version is to abolish boulder measurement and compel the contractor to figure his estimated cost of boulders into his earth excavation.

The reason for this intent is that the ordinary practice of paying for boulders as ledge leads to corrupt practice and the demoralization of the whole contract business.

I am writing this letter as a minority report on the assumption that the proposed substitute definition of Class A excavation will not prevail. I have the most excellent reason for this assumption, for I have been advocating this change for two years and have elicited, not only no support, but not even a reply, from any member from either committee, save one only, Mr. Potter.

I do not propose to discuss the whole subject at length as I have done previously in the correspondence, but will consider briefly Mr. Potter's attitude because it is typical of those who adhere to the old practice. He argues very locigally on the desirability of the city's assuming the risk of boulder as well as ledge excavation, but not a word as to the practicability of it. The argument is beside the point because the whole question is one of practicability only. Every one admits the desirability. So it is desirable to assume the much greater risk of quicksand;

why does no one do it? Solely because it is impracticable. This is the case with boulder measurement, it has been proven to be impracticable under ordinary municipal political conditions.

This change has been made in Boston and the result is unequivocally good.

Please present this letter as a minority report applying to the paragraph on Class A excavation only, except in the unlikely event of the adoption of the substitute by the Committee.

Motion was made to accept the majority report, which was seconded and carried.

W. W. HORNER (by letter):—As chairman of the 1921 Committee on Sewers of the A. S. M. I., I wish to call attention to two matters which the committee last year did not reach, but which I think are important, and which should be commended to the consideration of the new committee as part of the succeeding year's work. These relate to the specifications for sewer pipe, and the segmental sewer block.

You will note that in the tentative specifications the new standard sewer pipe specifications, as agreed upon between the A. S. T. M. and the manufacturers, are accepted. Upon investigation, however, I find that many city engineers thruout the country are still calling for some of the various varieties of the old specifications; that is, for single strength, for double strength pipe, and for deep and wide socket pipe. I am inclined to doubt the necessity for adhering to these various specifications, and believe that the Society can do good work in promoting the use of the new standard specification thruout the country. I think this can be done by means of a supplemental report on this particular subject.

I have also noted the number and variety of styles of segmental block offered for sewer construction. Some of these are extremely valuable material, while the advantage of others may be seriously questioned. While somewhat out of line with the work of previous committees, I am inclined to recommend that the committee make an investigation of all segmental block offered by the manufacturers, that in doing this they secure cooperation of the manufacturers to the extent of tabulating complete data on all styles on the market, and supervising tests as may seem advisable.

REPORT OF COMMITTEE ON SPECIFICATIONS FOR SUB-GRADES AND FOUNDATIONS

Frederic A. Reimer, Chairman, Newark, N. J.

Your Committee on Sub-Grades and Foundations submits the following report.

In preparing the report, the Committee has had the assistance of Henry G. Shirley, of the Federal Highway Council, Philip P.

Sharples of the Barrett Company, Prevost Hubbard of the Asphalt Association and the valuable report of the Special Committee on Foundations for Pavements, as printed in the Annual Proceedings of the 1920 Convention, pages 381 to 394 inclusive.

Your Committee recommends the following changes to the specifications as printed:—

Broken Stone Foundations for Pavements

Under the heading "Sub-Grade" line 5, change the word "distance" to "depth."

Strike out entire second paragraph and substitute the following:—

"After rough grading has been completed, the surface of the sub-grade shall be brought to the required grade and cross-section and rolled with a power roller weighing not less than twelve (12) tons, until the surface thereof is unyielding. If required by the engineer, the sub-grade shall be drenched with water before rolling. Depressions or ruts occurring from any cause shall be brought to grade with good earth and thoroly rolled as above specified. Any portions of the sub-grade which are inaccessible to the roller shall be thoroly tamped with tampers weighing not less than forty (40) pounds, and having a face which shall not exceed eighty (80) square inches in area. All soft, spongy and unyielding spots and all perishable matter shall be entirely removed and the space filled with suitable matter.

Wherever clay, adobe, or soils of similar character are encountered, they shall be excavated to a depth of at least two (2) inches below the established grade of the sub-base. There shall then be provided a layer of coarse gravel, sharp sand, or other suitable material, which will afford proper drainage. This material will be brought to the established sub-grade and properly shaped and rolled."

Under the heading "Sub-Drainage," in line 1, paragraph 1, after the word "when" add the words "in the opinion of the engineer."

In line 5, change the word "should" to "shall" and add after the word "provided" the words "and constructed as directed by the engineer."

It is the opinion of the Committee that the balance of the specifications as printed in the 1920 proceedings, should be stricken out, as they are more in the nature of description of drainage than specifications. Inasmuch as there are so many designs for under-drainage, the Committee believes it should be left entirely in the hands of the local engineer to decide.

New Macadam Foundation

Strike out entire specifications, and substitute the following:—

"After the sub-grade has been properly prepared, there shall be spread a layer of clean, broken trap rock or other suitable stone, which shall pass a three-inch ring and be retained on a two-inch ring, said stone to be spread in a uniform layer and shall have a depth, after final compression, of six (6) inches.

"On this course of stone there shall be spread in uniform layers about one inch in thickness, screenings or sand, or a mixture thereof, acceptable to the engineer, which shall be swept into the interstices, and this operation shall continue until said interstices are completely filled. During the spreading of this binder the rolling shall continue until the foundation is thoroly filled and solidly compacted to the satisfaction of the engineer.

"This binder shall not be applied in such quantity as to cover or form a coating over the top of the stone foundation. Any surplus binder which shall remain over the surface of this foundation shall be removed before the surface pavement or any second course of stone is laid."

"Bank gravel or sand may be used for filling the interstices when same is approved by the engineer."

Old Macadam Foundation

Paragraph 1, line 1, strike out the words "if the pavement is to be laid on an old macadam base."

Specifications *Asphaltic Base* recommended without change.

Specifications for Tar-Bound Base—Hot Penetration Type

Under the heading "Sub-Grade" strike out entire paragraph and substitute specifications as recommended under "Broken Stone Foundation for Pavements."

Under the heading "Three-Quarter-Inch Stone" in line 3, strike out the words "one and" so that it will read "one-half-inch ring." Change numerals to conform.

Under the heading "Refined Tar for Sand Tar Cushion," line 1, strike out the words "base and."

Specifications for Tar-Bound Base—Cold Penetration Type

Under the heading "Sub-Grade" strike out entire paragraph and substitute suggestion as recommended under "Broken Stone Foundation for Pavements."

Under the heading "Applying Refined Tar," lines 4 and 5, strike out "so that it will not pick up before applying the next," and substitute "until there is no excess bitumen on the surface of the road before making additional application."

Suggestions have been made that the specifications for asphaltic base, tar-bound base, both hot and cold penetration type, should be prepared so that in the asphaltic base coal-tar pitch as a binder be used as well as the asphaltic cement, and in the hot and cold penetration types that asphalt be used as well as the tar. These suggestions, however, have not been agreed to by the Committee, and are submitted with the hope that there will be a general discussion on the advisability of adopting these changes, and from the discussion a decision reached, either by the Convention or left for decision to the new Committee.

Your Committee recommends that the above changes be adopted, and that the specifications then be printed as tentative, without formal approval by the Society. The reason for this recommendation is that there are now being conducted by the Federal Highway Council and other committees interested in sub-foundations, experiments which it is hoped will be completed before the next annual convention, and that the conclusions reached from these experiments may be incorporated in further amendments.

On motion the report was accepted and ordered printed in the Proceedings as tentative specifications as requested in the last paragraph.

REPORT OF COMMITTEE ON SPECIFICATIONS FOR STREET RAILWAY PAVEMENTS INCLUDING TRACK CONSTRUCTION

Charles E. DeLeuw, Chairman, Chicago, Ill.

During the year, the Committee sent out a letter to those members of the society, who we thought would be interested, asking for information relative to street railway pavement practice. A very gratifying response was made to this letter and in so far as possible we have tabulated the replies as shown below:

The replies received were most interesting and lack of space only prevents their presentation in full. We give below abstracts of letters which bring up points of particular interest.

W. E. Rew, Engineer Highways and Bridges, Norfolk, Va., gives the following:

1st—Types of pavements laid: Sheet asphalt, durax, granite block on sand, granite block on concrete with mastic filler, wood block.

2nd—Most successful type: Sheet asphalt. We are looking for good results from Durax but this type has not been in use long enough to justify an expression as to its durability in car tracks.

3rd—Unsuccessful pavements: I do not feel that any of the pavements enumerated could be termed unsuccessful; wood block has perhaps proven less successful than any of the others, but faulty track joints have been more largely responsible for failures than the pavement itself.

4th—Track construction used: This is clearly shown on the enclosed blue print. The use of tie plates and the welding of the joints are very important factors in this construction. If the joint can be held rigidly little trouble is experienced. (Drawing not reproduced.)

5th—Sections of rail found satisfactory: Lorain Steel Co's., 122 lb., section 491, 7-in. grooved girder.

6th—Nature of pavement and track foundation used successfully: This, I think, is answered in 2 and 5.

7th—Preparation of sub-grade: Sub-grade is rolled with 5 or 10-ton toller, preferably 10-ton if soil will permit.

8th—Surface drainage and sub-drainage provisions: Surface drainage is taken care of in the gutters where grades permit, otherwise by means of catch basins and underground pipe lines. The soil in this locality being very sandy it is but seldom that we have to resort to sub-drainage. In one or two instances where the surrounding territory has been low and water-logged, we have used drain tile laid along the track area.

This type of construction has been in use in Norfolk for about fifteen years and where proper welding of the joints has been secured, and the tie plates used, but little trouble has been experienced.

R. A. MacGregor, New York City, writes as follows:

In this city all kinds of pavements are used in the railroad area which includes the space in and between the tracks and a strip two feet wide outside of the track. In most cases the same kind of pavement is used in the railroad area as in the rest of the street but this is not insisted on. The pavement, however, of whatever kind, must be up to the city specifications for the kind selected. For about four or five years the companies in Manhattan have been using granite principally, in and between tracks, while the 2-foot strip conformed to the rest of the street, and about three years ago they began laying two courses of stretchers outside of each outside rail when the street pavement is asphalt. These blocks are set in a dry mortar bed and the joints filled with tar or asphalt mastic. The concrete foundation is recessed to allow for the extra depth of the blocks and after they are laid is carefully pointed up with mortar, making a solid concrete bearing for the blocks. This construction is quite successful, preventing the cracking of the asphalt due to rail movement and still keeping the joint of the two pavements within the railroad area. Wood and granite blocks are laid right up to the rails.

In Manhattan practically all tracks are of the under-ground trolley type, while in the other boros the track is the usual wooden tie type ballasted with broken stone. The rail is always a grooved rail seven or nine inches deep.

Very little preparation of the sub-grade is done, to some extent because a large proportion of the streets are sewered and thus the subdrainage is provided. At sumps road boxes with slotted covers are installed in the track and connected with the sewer.

Before laying granite or wood block pavement against the rail the space between the web and the edge of the head of the rail is filled with a stiff 1 to 3 portland cement mortar.

In the case of asphalt pavement, this space is filled with binder thoroly packed in by the use of hot tamping irons.

All pavements in Manhattan are laid on concrete foundations, and except for granite on sand foundation this is the case in all the other boros.

Roy C. Gans, Engineer, Department of Streets and Sewers, St. Louis, writes:

1. Street railway pavements are handled by the street railways company and not until recently has the city taken more than a passive interest in the details of construction.

2. The present practice is to exercise some supervision over such construction work because of its effect on general traffic conditions and the present practice is to require that track be laid on a concrete foundation and ties embedded in concrete.

3. Street railway pavements and track construction:

(a) Types of pavement laid:—Granite block, sand bed and filler; Vitrified brick, concrete foundation and grouted; Wood block, concrete foundation and grouted; Cut granite block, concrete foundation and grouted.

(b) Most successful type:—Cut granite block, concrete foundation and grouted.

(c) Unsuccessful pavement:—Granite block, sand bed and filler; Wood block, Asphalt.

(d) Track construction used:—On paved streets, ties imbedded in concrete foundation which is brought to subgrade of wearing surface. Chairs usually used to compensate for change of rail section from girder to "T."

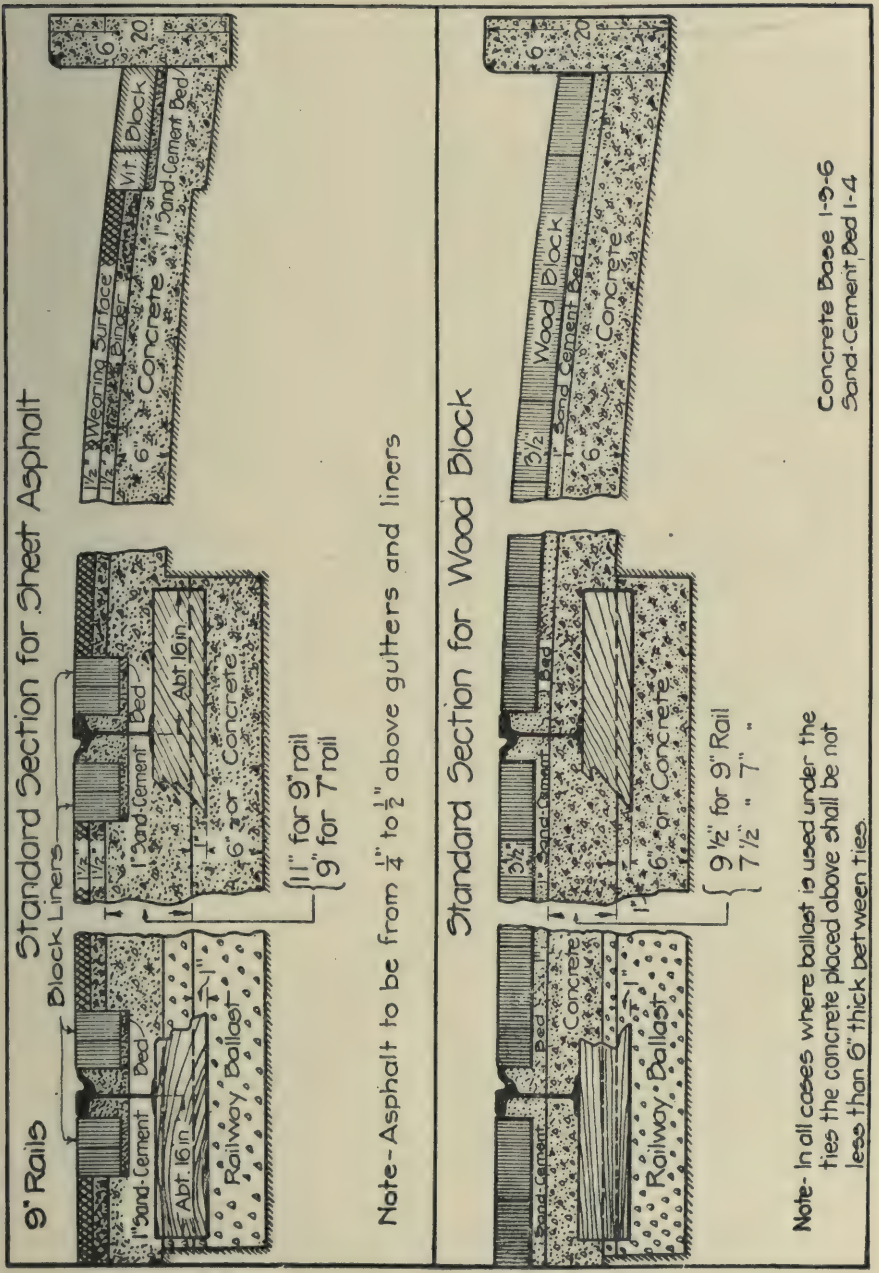
(e) Section of rail found most satisfactory:—Girder rails, being replaced by T-rails where conditions will permit.

(f) Pavement and foundation used successfully:—Cut granite block, grouted, on concrete foundation; Vitrified brick, grouted, on concrete foundation with granite headers next to rail.

4. Opinions above expressed are based upon observations of about fifteen years.

Present practice in Elmira, N. Y. is represented by Thurber A. Brown, City Engineer, as follows:

Our most successful type is brick filled with pitch or asphalt. The Street Railway Co. in 1914 adopted as standard for new construction a Lorain 7-in. T-Rail, Sec. 91, No. 375, 91 lb. per yd., a 6-in. oak tie spaced 2 in. on centers with 6 in. stone ballast under the 5 in. of 1:2½:5 concrete base, 1½ in. sand cushion and 4-in. block ¼ in. below the top of rail, Nelsonville stretchers and


9" Rails
Block Liners
Standard Section for Sheet Asphalt
1" Sand-Cement
Bed
Abt. 16 in
Railway Ballast
1"
1½
1½
1" Sand-Cement
Bed
Abt. 16 in
1"
6" or Concrete
11" for 9" rail
9" for 7" rail
1½ Wearing Surface
1½ Binder
6" Concrete
Vit. Block
1" Sand-Cement Bed
6
20
Note-Asphalt to be from $\frac{1}{4}$" to $\frac{1}{2}$" above gutters and liners
Standard Section for Wood Block
Sand-Cement
Bed
Concrete
Railway Ballast
1"
3½
Sand-Cement
Bed
1"
6" or Concrete
9½" for 9" Rail
7½" " 7" "
3½
Wood Block
1" Sand Cement Bed
6" Concrete
6
20
Concrete Base 1-3-6
Sand-Cement Bed 1-4
Note- In all cases where ballast is used under the ties the concrete placed above shall be not less than 6" thick between ties.

fillers for the inside and the web plastered with a 1:1 cement-sand mortar under the head of the rail, on the outside.

P. C. Painter, City Engineer, Washington, N. C., gives the following interesting notes based on his experience in Baltimore and many points in the South and Middle West:

Our design of paving for car-track streets was always based on brick between outer rails, regardless of the type of paving on the shoulders. When a bituminous material was used on the shoulders we put in a double line of granite block liners and paved the bituminous material up to them, never in any case paving a brick shoulder beyond the outside rail unless the street was brick from curb to curb.

In Baltimore we used a 4-in. wire-cut lug brick and cement grout, but I am convinced by the work I have seen thru the Middle West that a better design would be plain wire-cut brick without lugs, laid with the wire cut surface up, and filled with asphalt, the asphalt applied hot with a squeegee, so as to completely fill the joints and leave a uniformly thin coating of asphalt over the top of bricks. This seems to give just the right amount of flexibility, but still retains the advantages of a rigid material. It is also much easier to open up for repairs to rail, and can be repaired in such a way that the cuts are not noticeable.

I have also had a great deal of success with granite and durax blocks in the track but the greatly increased cost of that material over brick has, even in view of its slightly longer life, never seemed to me to justify its use except under heaviest iron tired traffic conditions.

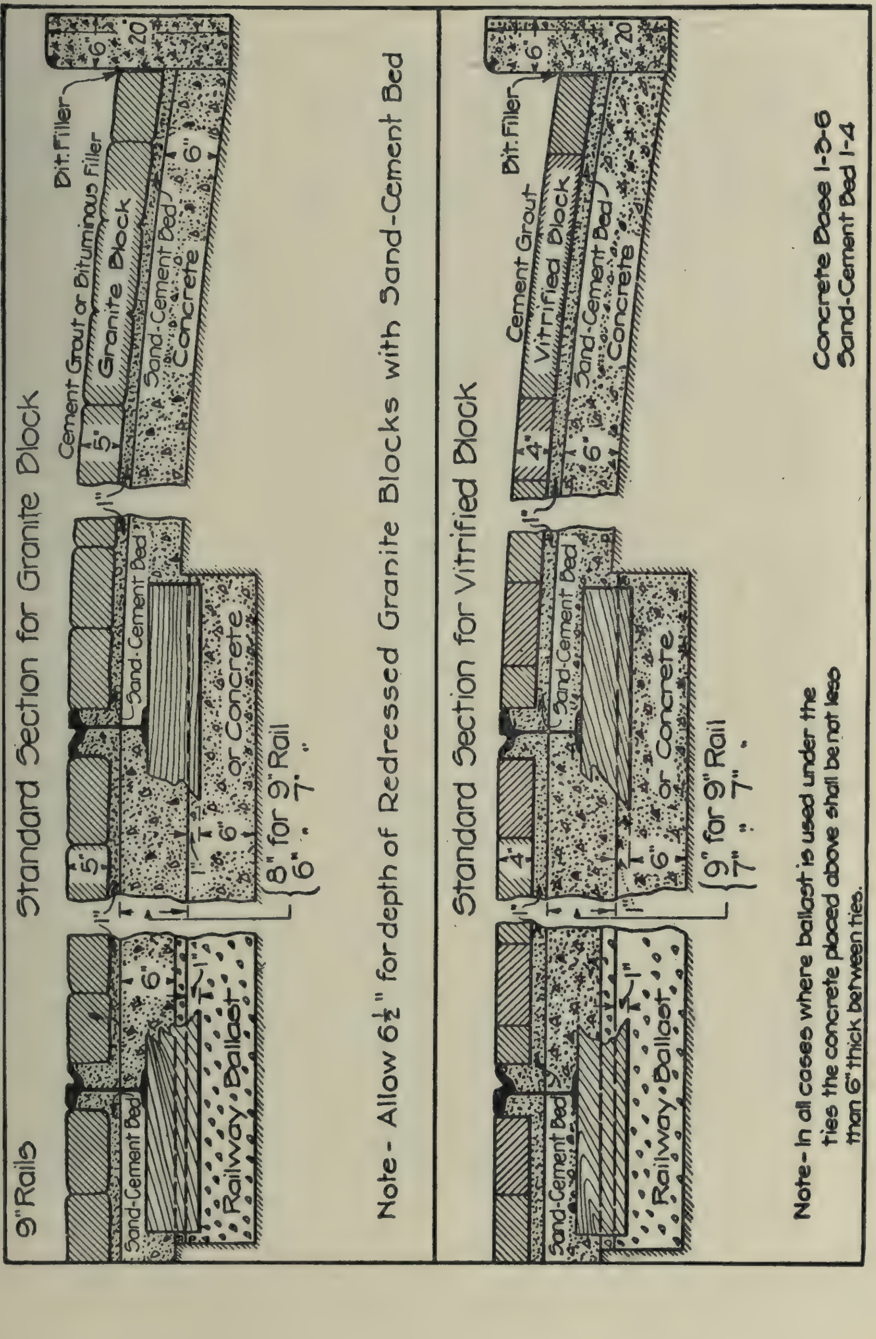
Other than these two, I do not believe that any type of material can be made to stand up under the strain placed on the paving in the railway area.

I would recommend for track construction a 7-in. girder rail on stone ballast, and thoroly compact sub-grade, with brick laid in 1-inch cement-sand cushion and a six (6)-in. concrete base, with the ballast built up to meet the concrete base.

On streets where the street-car traffic is excessive, concrete should be substituted for the stone ballast unless there is ideal sub-drainage.

I have found that the greatest trouble with street railway pavements develops at the special work, especially at the frogs and switch points, and I have found that 4-in. or 6-in. vitrified pipe, laid with open joints, and sufficient short Y branches to cover the area of the special work, helped matters wonderfully. Otherwise I have never encountered conditions which would justify sub-drainage.

For surface drainage a long narrow catch basin about 18″ wide, extending from rail to rail in each track, with the dummy slightly crowned to throw the water to the track, seems to answer the purpose most satisfactorily.


9" Rails
Standard Section for Granite Block
Sand-Cement Bed
Railway Ballast
6"
1"
5"
Sand-Cement Bed
or Concrete
8" for 9" Rail
6" " 7" "
1"
Cement Grout or Bituminous Filler
Bit. Filler
Granite Block
Sand-Cement Bed
Concrete
6"
20
Note - Allow 6½" for depth of Redressed Granite Blocks with Sand-Cement Bed
Standard Section for Vitrified Block
Sand-Cement Bed
Railway Ballast
1"
4"
Sand-Cement Bed
or Concrete
9" for 9" Rail
7" " 7" "
6"
Cement Grout
Bit. Filler
Vitrified Block
Sand-Cement Bed
Concrete
20
Note - In all cases where ballast is used under the ties the concrete placed above shall be not less than 6" thick between ties.
Concrete Base 1-3-6
Sand-Cement Bed 1-4

Col. R. Keith Compton, Chairman and Consulting Engineer of Paving Commission, Baltimore, gives the following:

(a) Types of Pavements laid: Sheet asphalt, with two rows scoria block as liners, asphalt filler; Sheet asphalt, with two rows wood block liners, asphalt and cement filler; Sheet asphalt, with two rows new granite block liners, asphalt and cement filler; asphalt with two rows redressed granite block liners, asphalt and cement filler; Vitrified block, cement filler; New granite block, cement and asphalt filler; Redressed granite block, cement and asphalt filler; Scoria block, asphalt filler; Wood block, asphalt filler.

(b) Most successful type:—For very heavy traffic, granite block, new or redressed, between outer rails, cement filler except where asphalt filler is used where traffic will not allow cement filler time to set. For moderate traffic, sheet asphalt between outer rails between blocks, with wood block or granite block liners. Under this construction, granite block, new or redressed, is placed at main street crossings between outer rails, using cement or asphalt filler. For moderate traffic, vitrified block, cement filler, and cement-sand bed between outer rails. For light traffic, sheet asphalt between outer rails, with wood or granite block liners.

(c) Unsuccessful Pavements:—Vitrified block or scoria block as liners, also shallow wood block, (deep wood block very successful); Sheet asphalt between outer rails at main street crossings where traffic is heavy.

(d) Track Construction used:—Rail on wood tie, rock ballast, where sub-grade is good and car traffic moderate; Rail on wood tie, concrete slab, with cushion under tie, where car traffic is heavy; Rail on steel tie enveloped in concrete, where car traffic is heavy. See sketches for this heading.

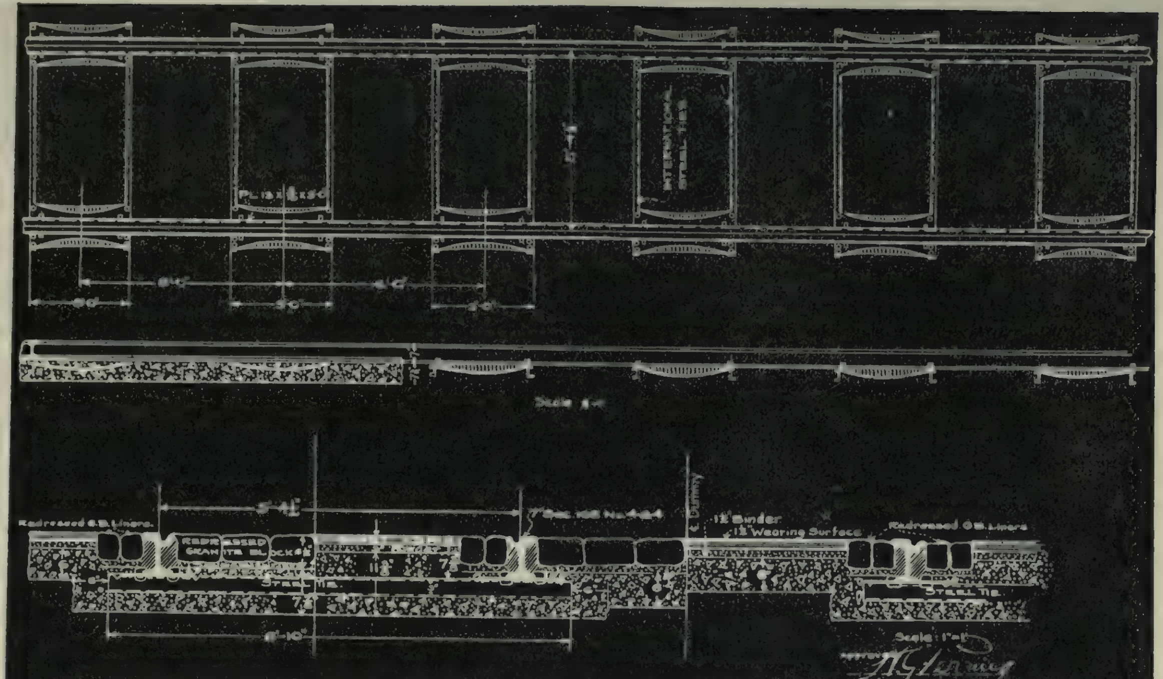
(e) Section of rail found most satisfactory:—7 in. grooved girder type. "T" rail now being used on wide streets, outlying sections.

(f) Nature of pavement and track foundation used successfully:—Concrete under paving 1–3–6 mix, rock ballast or concrete under ties and rails. See sketches.

(g) Preparation at sub-grade:—Peculiar conditions exist in this city, in that our down-town streets are narrow and congested, so that it is almost impossible to re-route cars while track and paving are being laid. Therefore, there is no chance of giving sub-grade any special treatment except as noted under next heading.

(h) Drainage provisions:—Track drains on surface for excessive flow or for low spots in grade; Tile drains in dummy strip where sub-grade is poor and springy; Drains connecting with track drainage and thence to nearest storm water inlet; Instances are few, however, where sub-drainage is necessary.

First concrete under ties since 1913. Various classes of paving in use with moderate repairs from one to fifteen years. Failures



AVERAGE DEPTH OF CONCRETE IN RAILWAY AREA ON CHARLES ST			
ITEM NO	TYPE OF PAVING.	STEEL TIE CONSTRUCTION	WOOD TIE CONSTRUCTION
4.	Sheet Asphalt-1½" Wearing Surface-1½" Binder	9¾"	——
10.	Redressed Granite Block-Cement Filler.	7½"	5¼"
25.	Granite Blocks Redressed as Liners-Cement Filler.	7⅞"	3¾"

Steel tie construction to be used in Charles St. for straight track only-Wood tie construction to be used for special track work. (See sketches on pages 60 & 61.)
Concrete to be placed under and around steel ties by contractor.
" " " " " " " Wood ties by U.R.&E. Co. (See sketches on pages 60 & 61.)

Chief Engineer

CONTRACT No 182-OC

CITY OF BALTIMORE
DEPARTMENT OF PUBLIC IMPROVEMENTS
PAVING COMMISSION
DETAILS OF STEEL TIE CONSTRUCTION [illegible] ON
CHARLES ST-LOMBARD to SARATOGA
SCALE: 8"=1' & Full FEB. 7, 1921
Assoc. Civ. Eng.-Highways Chairman & Consulting Eng.

in paving have been due almost invariably to poor, out-of-date track construction and worn-out rail when paving was installed. There are cases in this city, where paving has by far outlasted the rail. This is particularly the case with special work. If the railway company had pursued the up-to-date practice ten years ago that they are following today, very few failures would have occurred in track pavements.

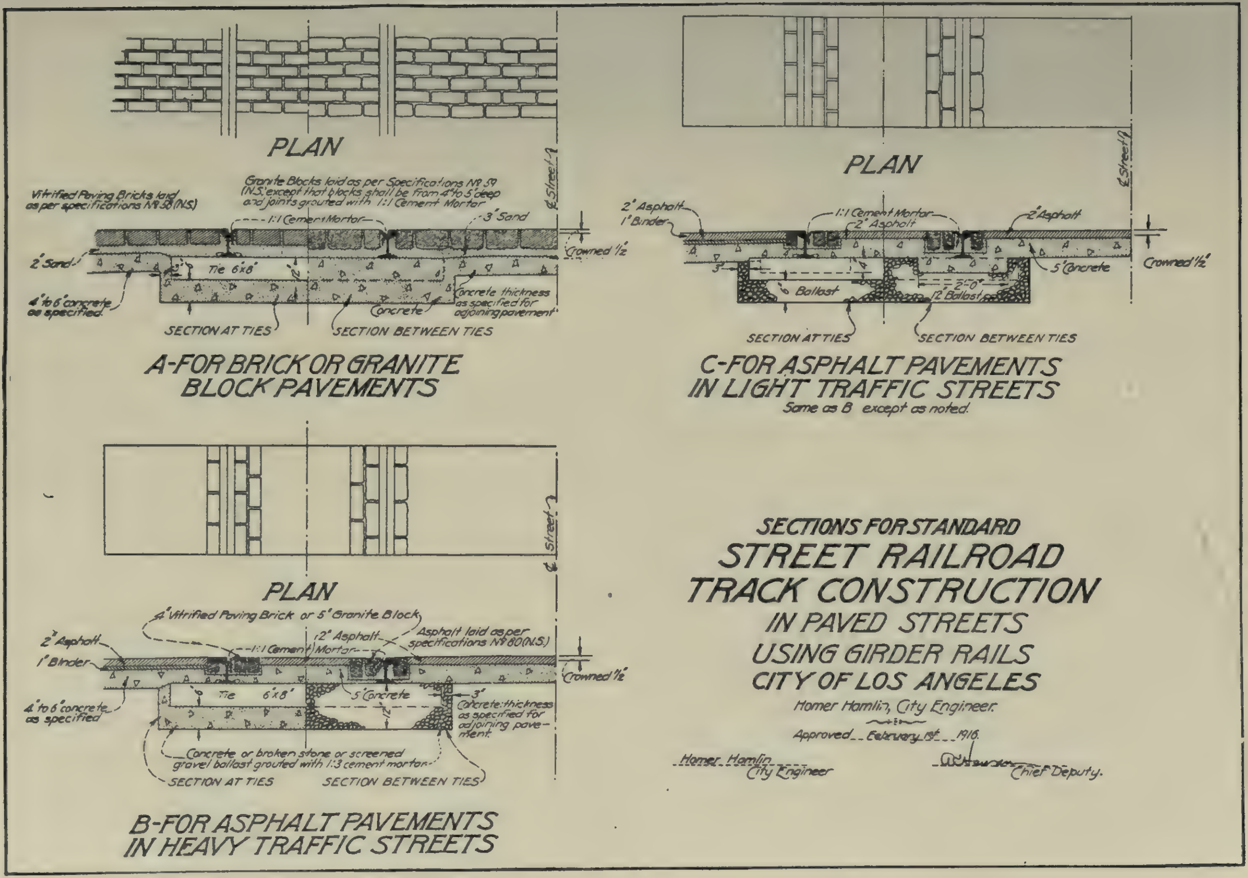
Will P. Blair, Vice-President National Paving Brick Manufacturers Association, Cleveland, Ohio, gives interesting data as follows:

I may say that in the city of Cleveland and in the street car tracks, there have been laid almost every kind of pavement and various types of all kinds and this applies to both tracks and street construction. The street car company is not wedded to any particular type of construction and it is still looking for the most successful type. Necessarily it follows that there has been no successful street railway construction in the City of Cleveland, yet this statement needs to be qualified in order to properly understand what is meant.

Various methods of construction have proved successful so long as accompanying conditions contribute to that success. By this I mean that there are sections of track where the drainage conditions are so perfect as to result in a uniform stabilization of the underneath conditions. This stabilization is more or less perfect according as it is maintained in a dry condition. Approximately 75% of the entire street pavements in Cleveland are of brick.

A great variety of methods are employed for the subdrainage of tracks, more or less successful, nevertheless to a greater or less extent the railway tracks regardless of the character of rail used receive between the rails the rainfall. There are but two ways for the disappearance of this water. It must either evaporate or percolate between any and every kind of paving material along the track and ties and thus impair the bearing power of the soil underneath. In my judgment there is but one way to prevent this and but one way in fact to construct the pavements in and about the street railway track and there is but one way to protect the city's portion of the street pavement. First, employ a curb between the city's portion and the street railway's portion just at the end of the ties. This protects against disturbance of the foundation by the vibration. The top of this curb should be laid flush with the pavement itself.

As to the construction underneath the track, I would use concrete installed level with the top of the ties. Upon the top of this I would instal a layer of bituminous material, the stone composition of which should be quite small. Upon this surface I would lay my wearing surface, be it of stone, brick or whatever wearing surface may be used. I would leave well exposed the bottom and all parts of the iron rail but in this void I would put a refined


PLAN
Vitrified Paving Bricks laid as per specifications Nº 58 (N.S.)
Granite Blocks laid as per Specifications Nº 59 (N.S.) except that blocks shall be from 4" to 5" deep and joints grouted with 1:1 Cement Mortar
1:1 Cement Mortar
3" Sand
℄ Street
Crowned 1½"
2" Sand
Tie 6"x8"
4" to 6" concrete as specified
Concrete
Concrete thickness as specified for adjoining pavement
SECTION AT TIES
SECTION BETWEEN TIES
A-FOR BRICK OR GRANITE BLOCK PAVEMENTS
PLAN
℄ Street
2" Asphalt
1" Binder
1:1 Cement Mortar
2" Asphalt
2" Asphalt
Crowned 1½"
5" Concrete
Ballast
2'-0"
12" Ballast
3"
SECTION AT TIES
SECTION BETWEEN TIES
C-FOR ASPHALT PAVEMENTS IN LIGHT TRAFFIC STREETS
Same as B except as noted.
PLAN
℄ Street
4" Vitrified Paving Brick or 5" Granite Block
2" Asphalt
1" Binder
1:1 Cement Mortar
2" Asphalt
Asphalt laid as per specifications Nº 80 (N.S.)
Crowned 1½"
Tie 6"x8"
5" Concrete
3"
12"
4" to 6" concrete as specified
Concrete thickness as specified for adjoining pavement.
Concrete or broken stone or screened gravel ballast grouted with 1:3 cement mortar
SECTION AT TIES
SECTION BETWEEN TIES
B-FOR ASPHALT PAVEMENTS IN HEAVY TRAFFIC STREETS
SECTIONS FOR STANDARD
STREET RAILROAD
TRACK CONSTRUCTION
IN PAVED STREETS
USING GIRDER RAILS
CITY OF LOS ANGELES
Homer Hamlin, City Engineer.
Approved February 1st 1916.
Homer Hamlin
City Engineer
Chief Deputy.

asphalt of a character which is disclosed in the Specifications of the National Paving Brick Mfrs. Association, of oil asphalt, using the same filler in case of brick or stone, to fill the joints of the same. By this method and by the use of this particular asphalt you have the concrete foundation as well as the sub-grade sealed against any influence of water from the surface, and that is the secret of maintenance of street railway tracks. It is the contrary that prevails and it is the contrary condition that is responsible for 95% of the injury affecting street railway construction.

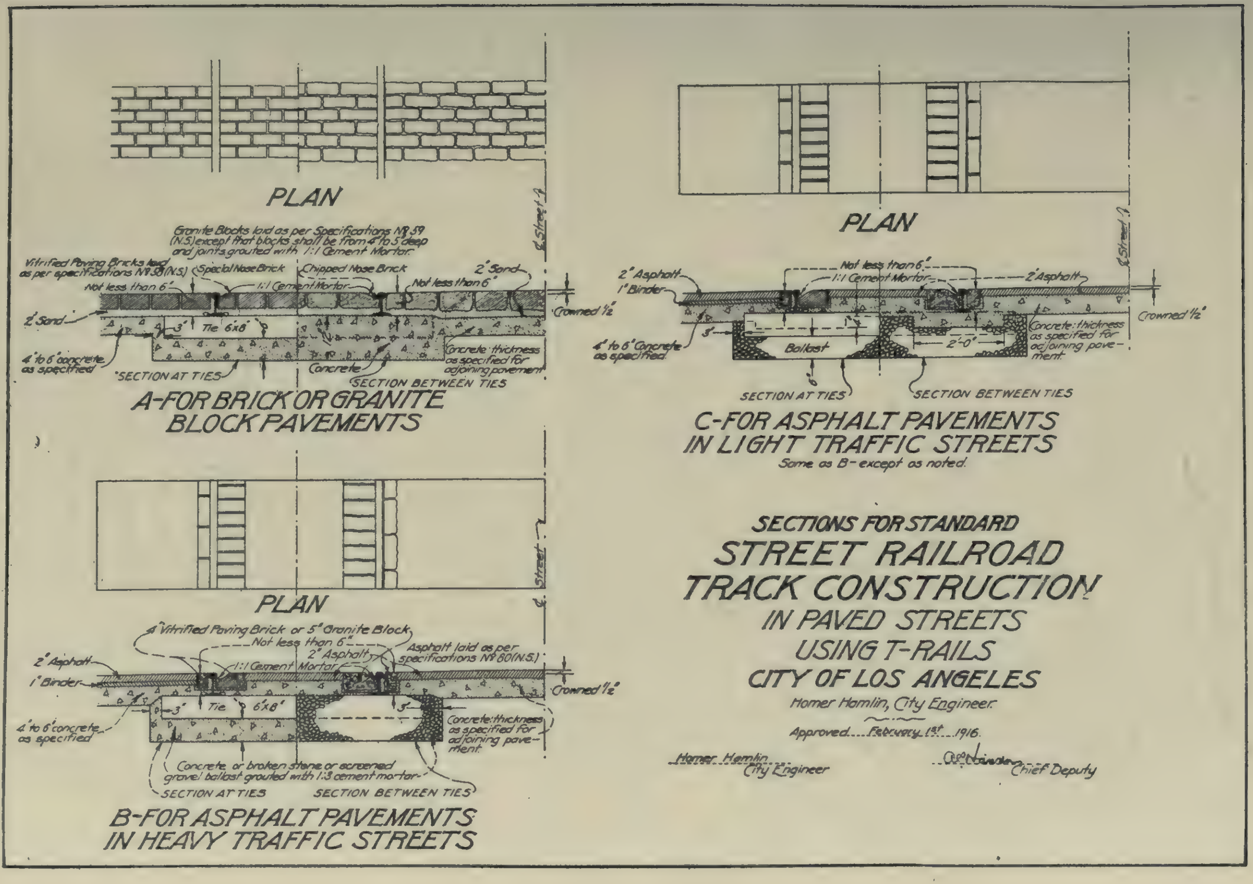
J. C. McVea, City Engineer of Houston, Texas, gives interesting data as follows:

Five or six years ago, a number of miles of track were laid embedding the ties in solid concrete, the concrete coming to within a distance equal to the depth of paving surface below top of rail. Due to the unstable condition of our soil, such track is liable to settle and become badly out of surface; the rails and ties being embedded in solid concrete are difficult and expensive to adjust. The Houston Electric Company, owners of our electric street railway system, are now using a different type of construction, briefly described as follows: A small tile drain is laid under the center of the track and the trench is filled with broken stone or gravel, inlets being provided at low points from the paving surfaces, and outlets being made at convenient points to storm sewers. Over the drain, and for a width of about 8 ft. on single tracks, is laid a 6-in. concrete base. On top of this base the track is laid and surfaced up on crushed rock, the rock coming to approximately the top of the tie. On top is laid 6-in. concrete paving base, upon which is laid the brick paving surface. If settlements occur in this construction, that part of the paved surface and base affected may be cut out and replaced without serious trouble.

John A Griffin, City Engineer, Los Angeles, California, writes:

The accompanying standard plans are offered for your consideration. The header blocks, however, are now omitted to save the initial expense and maintenance, and a smoother job is provided. Also the grouting of the rock ballast has, of late years, been omitted on lines of light traffic, perfectly satisfactory results having been obtained. The sub-grade is rolled with a 3-wheel, 12 or 15-ton roller, prior to the installation of the track, and an open joint tile drain is laid under each track. The Los Angeles Railway, using light local cars, operates on the track during the placing of the concrete for the paving base. The interurban line (Pacific Electric) diverts the traffic during the placing and about five days thereafter. Both companies have secured excellent results.

W. L. Hempelmann, Engineer, The Texas Company, 10 S. La Salle St., Chicago, Illinois, brings up the following interesting point in regard to a header course:


PLAN
Granite Blocks laid as per Specifications Nº 59 (N.S.) except that blocks shall be from 4" to 5" deep and joints grouted with 1:1 Cement Mortar.
Vitrified Paving Bricks laid as per specifications Nº 58 (N.S.)
Special Nose Brick
Chipped Nose Brick
Not less than 6"
1:1 Cement Mortar
Not less than 6"
2" Sand
2" Sand
Crowned ½"
3"
Tie 6"x8"
4" to 6" concrete as specified
Concrete
Concrete: thickness as specified for adjoining pavement
SECTION AT TIES
SECTION BETWEEN TIES
℄ Street
A-FOR BRICK OR GRANITE BLOCK PAVEMENTS
PLAN
4" Vitrified Paving Brick or 5" Granite Block
Not less than 6"
2" Asphalt
Asphalt laid as per specifications Nº 60 (N.S.)
1:1 Cement Mortar
2" Asphalt
1" Binder
Crowned ½"
3"
Tie 6"x8"
5"
4" to 6" concrete as specified
Concrete: thickness as specified for adjoining pavement
Concrete or broken stone or screened gravel ballast grouted with 1:3 cement mortar
SECTION AT TIES
SECTION BETWEEN TIES
℄ Street
B-FOR ASPHALT PAVEMENTS IN HEAVY TRAFFIC STREETS
PLAN
Not less than 6"
1:1 Cement Mortar
2" Asphalt
1" Binder
2" Asphalt
Crowned ½"
5"
Ballast
2'-0"
6"
4" to 6" Concrete as specified
Concrete: thickness as specified for adjoining pavement
SECTION AT TIES
SECTION BETWEEN TIES
℄ Street
C-FOR ASPHALT PAVEMENTS IN LIGHT TRAFFIC STREETS
Same as B-except as noted.
SECTIONS FOR STANDARD
STREET RAILROAD
TRACK CONSTRUCTION
IN PAVED STREETS
USING T-RAILS
CITY OF LOS ANGELES
Homer Hamlin, City Engineer.
Approved.....February 1st 1916.
Homer Hamlin
City Engineer
Chief Deputy

I believe one feature of most importance and which has only begun to be recognized by certain engineers to date is the inclusion of a header course immediately outside of the railway ties. Such header course laid flush with the pavement should be of a material that will wear in a manner similar to the adjoining pavement. To date I think that the granite header serves this purpose better than anything of which I have knowledge. The inclusion of the header course definitely restricts the damage done to the pavements because of any disturbances brought about thru the street car traffic and particularly insures construction conditions similar to those involved in paving a narrow curbed roadway. I would suggest that your committee look into this matter. I am of the opinion they will conclude that the added cost to city pavements because of the inclusion of a header course outside of the ties will be found to be a justifiable expense. In addition to the above, one important reason is that such construction permits the complete improvement of the pavement areas from the curb to the header course without interference with the street railway right-of-way section. On the other hand the railway officials may improve their section without consideration or disturbance of the adjoining pavement.

Clarence D. Pollock, Consulting Engineer, Park Row Building, New York City, N. Y. gives the following notes covering twenty years of observation:

Types of Pavement laid: Asphalt, asphalt block, asphalt concrete, standard granite block, durax, wood block, brick, slag block, and years ago macadam.

Most successful type: Standard granite block pavement on concrete foundation using an asphalt mastic filler. Second best the same as above but using portland cement grout filler. Other good forms have been durax on concrete foundation with asphalt mastic filler; where city officials have insisted upon asphalt in the tracks and between the tracks I have obtained good results by using 5-inch depth granite blocks imbedded in the fresh concrete base along each side of each rail, and then filled in between these granite courses with sheet asphalt pavement. This form of construction I used successfully in Danbury, Conn. In Brooklyn, N. Y., I have obtained good results by placing granite blocks in the form of toothing along the rails, a pair of short blocks and then a pair of long blocks alternating. This gives sufficient width to tamp the asphalt thoroly.

Unsuccessful pavements: Sheet asphalt, asphalt concrete, wood block and brick laid directly against rails with the ordinary track construction where no ballast was used under ties.

Track construction used: The best track construction that I have used is where broken-stone ballast has been placed under creosoted ties and then concrete placed between the ties or where concrete has been placed under and between the creosoted ties or steel ties.

Section of rail found satisfactory: Grooved girder rail. Have also gotten pretty good results from T-rail mounted on chairs in order to obtain depth above the ties for standard granite blocks, and bolting Z-bars to the web of the rail for the purpose of forming a groove for the flange of the car wheel.

Preparation of sub-grade: The sub-grade should be thoroly compacted before the broken-stone ballast or concrete is placed.

Surface drainage and sub-drainage provisions: Surface drainage is usually taken care of by the catch basins or inlets in the street gutters, but at the low points in the track it is usually advisable to place transverse grating in each track to take care of the water in the groove of the rails. In case the sub-grade contains clay it is often advisable to use open tile drains or blind drains of broken stone to insure a good firm sub-grade for the track ballast or concrete.

Mr. C. E. Hawkins makes the following report covering types of pavement in track laid in St. Louis.

Types of Pavement Laid: The types of pavement include creosoted wooden blocks, asphalt, grouted Missouri, Georgia and Wisconsin granite blocks, grouted redressed granite blocks, grouted vitrified brick, concrete and macadam.

Most Successful Type of Pavement: The most successful type, I believe, is the redressed granite block, which is generally made from old blocks by cutting them down to a smaller size. Blocks cut down in this manner have good smooth surfaces and lay up so as to make a very smooth track pavement, much more satisfactory than the pavement made with standard size granite blocks. The redressed blocks are grouted with a cement-sand grout. Automobiles do not skid on it very much, at the same time it provides a good footing for horses during the bad part of the winter.

Most Unsuccessful Pavement: The most undesirable pavement is creosoted wood block pavement, for the reason that its life is short and it is very objectionable during wet weather if covered with mud or ice, as horses pulling heavy loads have great difficulty in standing up on the pavement at such times.

For a short time after snow falls the track is about the only part of the street that is cleared of snow, and there is a great amount of objection to the delays caused by horses in the tracks being unable to stay on their feet.

We have laid a large amount of wooden block pavement on a hard, specially surfaced, cement-and-sand mortar, surfaced about like a granitoid walk, the blocks being laid in hot Stanolind asphalt filler, poured on the hardened mortar bed after one side and one end of each block had been dipped in the hot asphalt. We have also laid blocks on a dry cement-and-sand base and also on a sand base but these methods do not give very good results.

We do not consider wooden block pavements a success in St. Louis, even tho some of them have stood up very well for a few years, as the cost of original installation plus the maintenance is excessive, the life of the pavement is short, and the smooth surface is the cause of too many blockades.

Track Construction Used: The majority of the straight track laid in St. Louis is laid with high T or girder rail on wood ties spaced two feet, center to center, with a solid concrete foundation extending from a plane six inches below the bottom of the ties to a plane from one to four inches above the top of the ties depending upon the proper height of base for the pavement to be laid in tracks.

The rail section found most satisfactory is the 100-lb. A. R. A. T-rail, 6 in. high, of which about 125 miles have been laid, altho about twenty miles of track laid with 7 in. high T-rail, Lorani Section 91–375, and 7 in. high T-rail, Lorain section 95–400, have been laid. In the congested districts 9-in. girder rail weighing 132 lb., known as Lorain Section 440, is used, but in some of the less congested districts a 7-in. girder rail weighing 103 lb. and known as Lorain Section 426, has been used.

We also have a large amount of 9-in. girder rail weighing 112 lb. per yard and known as Lorain Section 333, but this rail section is not satisfactory and is being renewed at the rate of some ten or fifteen miles a year.

We have not had very much success with broken stone and gravel ballasted track except in open construction in private right-of-way, for the reason that the almost impervious type of clay which we have in the sub-grade under most of our tracks, is difficult to drain properly and tile drains soon become filled with clay.

Rail Section Found Satisfactory: The 100-lb. A. R. A. T-rail, used in paved streets except where there is a large amount of tracking along the rail, has been found very satisfactory and is well liked by the city officials. 9-in. Lorain section 440 appears to be very satisfactory for the congested districts and the 7-in. Lorain section appears to be very satisfactory for the less congested districts.

Nature of Pavement and Track Foundation Most Successful: We believe that the redressed granite pavement and the solid concrete type of track foundation give the most satisfactory results under our conditions, altho we have had no experience with the concrete slab type of track foundation. Where first class brick can be secured, brick pavement with granite flange blocks along the T-rail gives a very satisfactory layout, but we have had some trouble with brick pavements due to the crushing or crumbling of the upper portion of the brick at spots. Practically all of our brick or granite pavements are laid on a sand base but some test sections have been put in with a dry cement-and-sand mixture as a base.

Preparation of Sub-Grade: Sub-grades are all prepared carefully. Loose material is removed, tamped or rolled, but the rolling is done with a 5-ton roller. Most of the settlement of tracks is charged to improperly filled water, sewer, gas or conduit ditches.

Surface Drainage and Sub-Drainage Conditions: All low points in the track are drained by manholes built in the track, the top castings having an opening about one foot wide and extending from one rail to the other. One type of manhole frame is used on girder-rail track and another type is used on T-rail track. All of these manholes are connected to the city sewers.

Sub-drainage is provided in all ballasted tracks with a 6-in. tile drain midway between tracks and about six inches below the track sub-grade. We have not made any connections between the tile drain and the rail. Tile drains are connected to sewers at frequent intervals to prevent overloading.

Blue prints showing the cross section of 9-in. 440 rail on concrete foundation, 7 in. 426 rail on concrete foundation and 100 lbs. A. R. A. T-rail on concrete foundation, are attached hereto. (Not reproduced.)

We have been using the concrete type of foundation since 1905. The 112-lb. 9-in. Lorain Section 333 was used almost exclusively on this type of foundation until 1911. Since 1911, the 100-lb. T, 7 in. high T-rail, 9-in. Lorain 440 and 7-in. Lorain 426 rails have been in use. The service secured from the 112-lb. rail, which is a poorly designed rail, varies from about two million to four million and one-half, depending on the care taken in the preservation of the joints. The 440 section has not been worn out in any case, some of it has carried 3,400,000 cars and some of the 7-in. 426 section has carried about 2,000,000 cars, with little indication of wear.

Joints: The method of jointing appears to be the most important factor in securing proper service out of rails. Various rail sections apparently permit welding better than other sections. This company has used the riveted Nichols composite rail joint with greater success than any other type of joint.

Henry Maetzel, Columbus, Ohio, is a member of this Committee and has written the following description of track construction methods in Columbus, which is given in full:

The increasing weight of street cars, faster schedules for their operation and the requirements of the city resulting from the radical changes in the nature of vehicle traffic on our streets in the past few years, have necessitated a type of street railway track and paving construction which was designed to meet these requirements.

The plan of construction generally followed on the more important streets of our city is as follows:

A trench 21 in. deep and 7 ft. 2 in. wide is excavated for each line of track; in this trench there is placed a sub-foundation slab

8 in. deep and full width of trench, composed of 1:2½:5 concrete. After this has thoroly set, the rails, consisting of a grooved section and weighing 122 pounds per yard, are set on steel ties 2 ft. 6 in. on centers, and 6 ft. 10 in. long, and weighing 14½ pounds per foot. The rail is fastened to the ties by means of steel clips and bolts. Before the rails and ties are placed, there is built between the two sub-foundation slabs in the case of double track, or on one side of the same in the case of single track, a line of common 6-in. drain tile with open joints, placed so that the top of the tile is just below the bottom of the sub-foundation slabs.

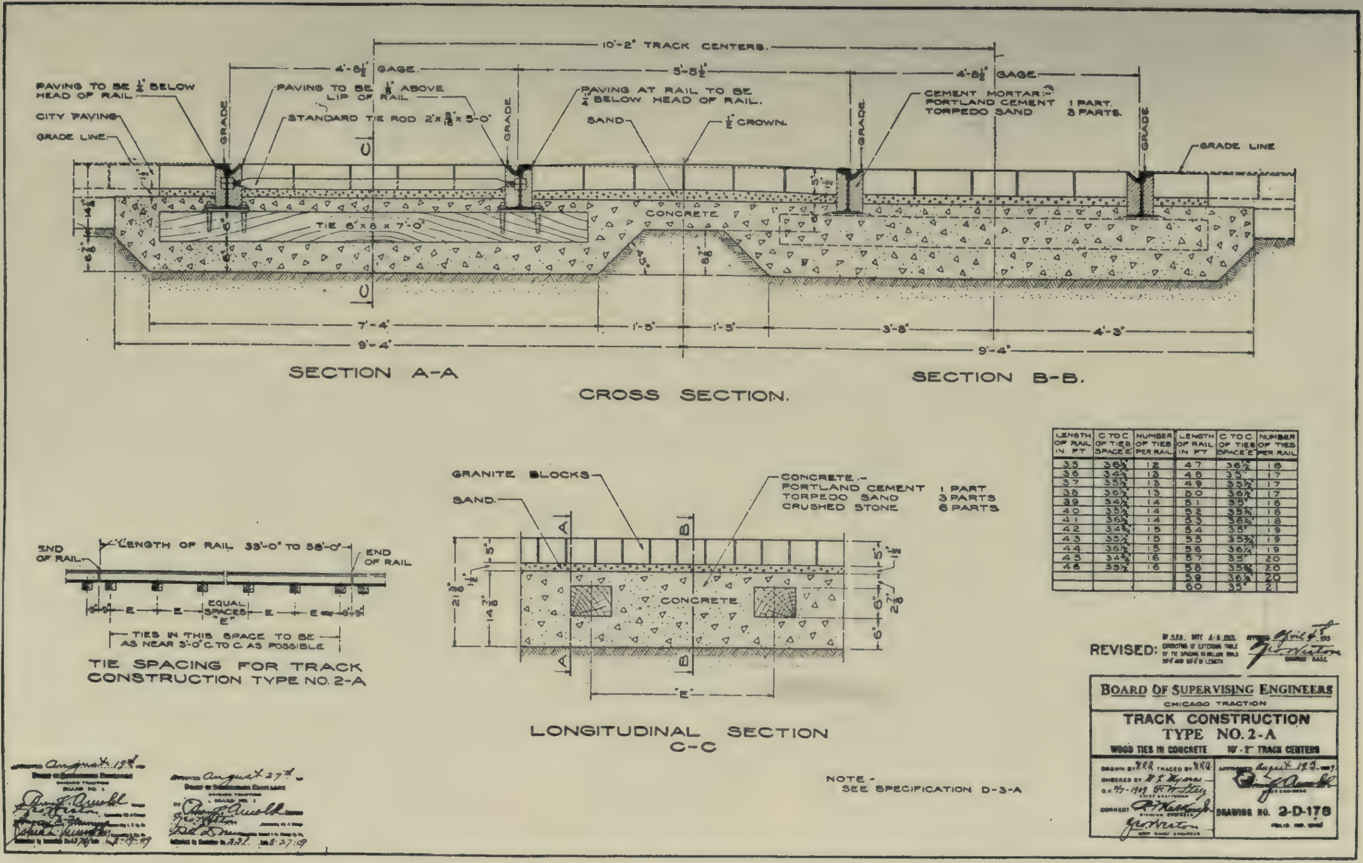
Track drains connecting with this drain-tile line and outletting into conveniently located catch basins or man holes by means of 8-in. sewer pipe are built at all grade sumps or on long grades about every 1000 feet. The space on top and around drain tile is then filled with loose gravel or broken stone to the top of the sub-foundation slabs.

After the track has been provided with the necessary joint plates and bolts, it is trued up for line and grade by means of small wood wedges under the ties; each joint is then provided with a joint support consisting of two feet of a section similar but slightly heavier than the one used for ties; this joint support together with the lower edges of the joint plates are then welded to the lower part of the rail, thus producing a welded joint for bonding, and also an additional support or anchor for each rail joint.

When the welding has been completed, a paving foundation of concrete of the same proportions as used in constructing the sub-foundation slab is built directly on the latter and extending to a height to permit the placing of the paving surface material. The paving foundation encases the ties and joint supports completely, and extends above the lower flanges of the rails; it is also carried across the dummy gage or devil's strip and for one foot outside of outer rails (franchise requirement) and there joins the paving foundation, supporting the roadway paving. The depth of this paving foundation is 7½ in. which leaves room between its upper surface and the top of the rail to permit the use of either a brick pavement or one of granite block meeting our specifications for depth.

After the paving slab is thoroly set, the spaces above this slab on both sides of the webs of the rail and flush with the top of rail are filled with a mixture of sand and cement in the proportion of 2½ parts sand to 1 part cement, which is placed sufficiently dry to permit its use without forms.

After this is dry, the pavement is placed, consisting of granite block or brick, or a combination of the two. On the one foot strip outside of the outer rails three lines of rather narrow granite blocks are used, set parallel with the rails if the roadways of the street are to be paved with sheet asphalt; if brick or granite is used on the balance of the street, then brick or granite is also used


10'-2" TRACK CENTERS.
4'-8½" GAGE.
5'-5½"
4'-8½" GAGE.
PAVING TO BE ½" BELOW HEAD OF RAIL.
CITY PAVING
GRADE LINE.
PAVING TO BE ⅛" ABOVE LIP OF RAIL
STANDARD TIE ROD 2"x ⅝"x 5'-0"
PAVING AT RAIL TO BE ¼" BELOW HEAD OF RAIL.
SAND
½" CROWN.
CEMENT MORTAR:- PORTLAND CEMENT 1 PART. TORPEDO SAND 3 PARTS.
GRADE
GRADE LINE
C
TIE 6"x8"x 7'-0"
CONCRETE
45°
7'-4"
1'-5"
1'-5"
3'-8"
4'-3"
9'-4"
9'-4"
SECTION A-A
SECTION B-B.
CROSS SECTION.
GRANITE BLOCKS
SAND.
CONCRETE.- PORTLAND CEMENT 1 PART TORPEDO SAND 3 PARTS CRUSHED STONE 6 PARTS.
A
B
5"
6"
"E"
LONGITUDINAL SECTION C-C
END OF RAIL
LENGTH OF RAIL 33'-0" TO 56'-0"
END OF RAIL
E
EQUAL SPACES "E"
TIES IN THIS SPACE TO BE AS NEAR 3'-0" C. TO C. AS POSSIBLE
TIE SPACING FOR TRACK CONSTRUCTION TYPE NO. 2-A
NOTE - SEE SPECIFICATION D-3-A

LENGTH OF RAIL IN FT	C TO C OF TIES SPACE "E"	NUMBER OF TIES PER RAIL	LENGTH OF RAIL IN FT	C TO C OF TIES SPACE "E"	NUMBER OF TIES PER RAIL
35	36½	12	47	36½	16
36	34½	13	48	35"	17
37	35½	13	49	35½	17
38	36½	13	50	36½	17
39	34½	14	51	35"	18
40	35½	14	52	35¾	18
41	36½	14	53	36½	18
42	34¾	15	54	35"	19
43	35½	15	55	35¾	19
44	36½	15	56	36¼	19
45	34¾	16	57	35"	20
46	35½	16	58	35¾	20
			59	36½	20
			60	35"	21

REVISED: BY R.R.Q. DATE 4-8 1913. CORRECTING OF EXTENDING TABLE OF TIE SPACING TO INCLUDE RAILS 56'-0" AND 60'-0" IN LENGTH. APPROVED April 8th 1913 Geo. Weston

BOARD OF SUPERVISING ENGINEERS
CHICAGO TRACTION
TRACK CONSTRUCTION
TYPE NO. 2-A
WOOD TIES IN CONCRETE 10'-2" TRACK CENTERS
DRAWN BY R.R.Q. TRACED BY R.R.Q.
CHECKED BY W. X. Myers
O.K. 8/7-1909 G. W. Stey CHIEF DRAFTSMAN
CORRECT DIVISION ENGINEER
Geo. Weston
APPROVED August 19th 1909
DRAWING NO. 2-D-178

APPROVED August 19th
APPROVED August 27th

2-D-178—TYPE NO. 2-A TRACK.

in the one-foot strip, all at angles to the rails. Between the outer rails and including the dummy gage, a pavement of granite block or brick set at right angles to the rails is used, the nature of the travel on the street and the kind of pavement used on the driveways determining which of the two materials is to be applied.

These paving surfaces are built and finished in the usual way, using either grout, tar or asphalt for a filler. On account of the advantage of its immediate use by the public, it is customary to use a filler of asphalt, tar or mastic at all street and alley intersections; this type of filler has given excellent satisfaction.

It has been found by experience that this type of construction has given very satisfactory results, and that the construction of the pavement of granite block provides an excellent paving surface for the use of the public, and one that is comparatively low in its maintenance cost.

This type of construction has been used in our city since 1914 and on the oldest jobs, altho the traffic, both by street cars and vehicles, is very heavy, the track and pavements are in excellent condition.

It might be urged that the use of the sub-foundation slab is an expensive and unwarranted outlay and that a very much cheaper construction could be designed omitting the same; while this is true, it must be remembered that the use of this sub-foundation slab is really a very large saving in the long run, as it represents a first outlay for all time to come; should it become necessary to rebuild the tracks at any time in the future, then such reconstruction begins at the top of this sub-foundation, and at no time will it ever be necessary to again disturb the same; in addition, its presence adds materially to the strength and stability of the entire construction.

The life of paving in car tracks is determined frequently by the design of the rails and the character of the rail joints.

Modifications in rail sections since the inception of street railways have been largely controlled by the change in equipment and by the need for a permanent paving. A brief historical sketch of rail and joint development may be of interest.

The strap rails (flat, without the web of a beam section) of early years, laid on stringers, spiked thru the flange way and without joints, were discarded and in their place a girder section, with a depth of 3½ to 4¼ inches was used. The joints were simple plates bolted to the web. These rails, rolled by the Johnson Company at Johnstown, Pa., are the parents of the modern girder rail, and in one of the earlier catalogs it was stated that by their use the cost of maintenance of tracks would be nearly eliminated. The same catalog, supporting the benefits to be derived by use of the new bolted joints, stated that "at last a permanent joint had been found" and that "the bolts would not loosen as the earth being firmly packed about the nuts would hold them securely in place, etc. Inability to maintain paving improvements along the rails was shortly felt and the so-called electric rail was developed by the Johnson Company. This rail was of the girder type, except that the base was replaced by a bulb-like section on the bottom of the web. To the bulb shape were fitted and electrically welded short lengths (6 in. pieces) spaced to conform to the tie spacing. These pieces had a base from 5 to 8 inches in width and the whole resulted in a rail with a total depth up to 13 inches.

This greater depth did not cure the paving or track difficulties. Heavier cars and greater loads with more frequent service came quickly and the modern type of rail was finally adopted. It was generally thought that a 7-in. to 9-in. rail would give ample depth for usual types of paving, the former for brick and the like and the latter for granite blocks.

During this period rail joint development occurred and many kinds of joints have been tried with more or less success. Cast welding had a considerable vogue after the successful work done by the Falk's in Milwaukee.

The Johnson Company developed the electric "butt weld," which was later replaced by the present well-known electric weld of the Lorain Steel Company. The Nichols rivetted joint, with open spaced filled with zinc spelter, was widely used in Philadelphia. Many improved mechanical joints have been tried with varying success, and while the number of joints per mile of track has been decreased by doubling the length of rails, yet joint trouble persists and cannot be eliminated. It can, however, be minimized by first-class workmanship in the original application of the joint plates, if a mechanical joint is used.

Conditions of service and the limited possibility of repair, should be carefully studied in order to select a good type of joint for street railway tracks.

Paving is damaged by motion of rails, however slight. Track of an absolute rigidity is economically, if not practically impossible. Water will enter about the rails and with the vertical motion, coupled with action of frost, will cause disintegration.

Assuming these facts as an important factor in the problem of paving maintenance, then paving must be designed and fitted to the rails in such manner as to reduce this mechanical action to the lowest degree, and at the same time permit free and economical maintenance and replacement.

There are so many factors which enter into the design of street track pavement, that the drafting of specifications which may fit all conditions is a very difficult task. A brief discussion of some of these factors may be helpful.

The character or composition of subsoil is an important factor in the design of track foundations. Soils which have low bearing values require heavy foundations. There are a few rare instances where ties laid directly on sub-grade have held track successfully the subsoil having high bearing power. Given the safe bearing value of the soil, the problem of design of foundations is reduced to simple mechanics. There are few data available on the bearing value of soils at the surface of the ground as most experiments have been made on soil to be found at the bottom of foundations of bridges or buildings. However, the data which are at hand show clearly the harmful effect water has on the bearing power of soils. Subsoil drainage is of utmost importance, as the bearing power of soils is directly affected by the amount of water contained.

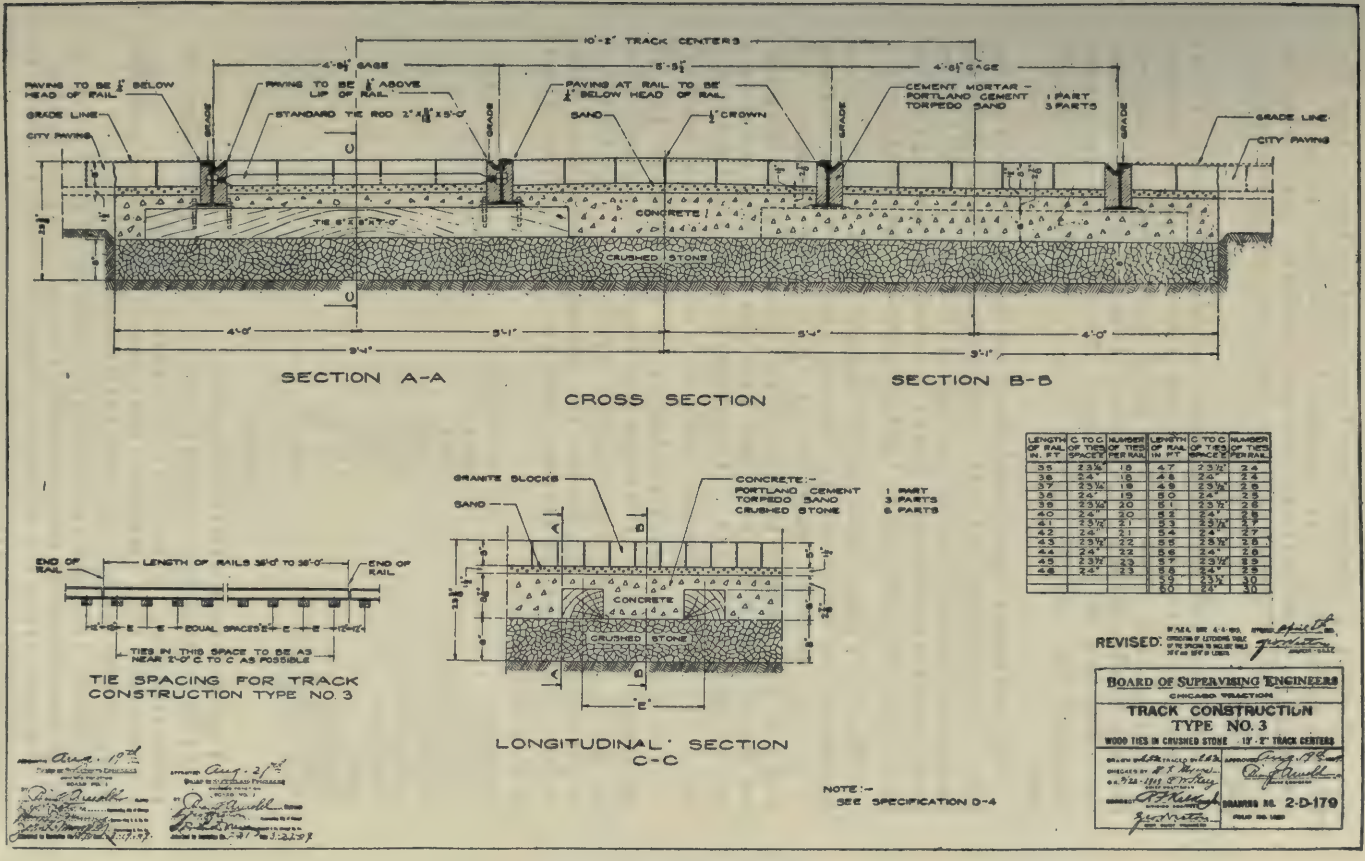
The great importance of sub-grade for pavements is being discussed more and more by engineers. It is generally agreed that all available means of increasing the bearing value of the sub-grade should be used. The means which are generally available are sub-drainage, and rolling the sub-grade. Provision has been made for both in these specifications.

There have been many different types of track foundations used in this country. These are generally reducible to three types. Plain ballasted construction, where the space between sub-grade and the bottom of the ties is filled with ballast; Solid concrete construction, where the track trench is filled with concrete extending solidly from sub-grade to the grade of the pavement foundation; Concrete slab sub-ballast construction, where a slab of concrete is laid in the bottom of the track trench and covered by a thin layer of ballast which extends to the bottom of the ties. All of these types have their proper uses and the specifications are so framed that a selection may be made which will be most suitable to local soil and traffic conditions.

The plain ballasted construction has many advantages; it is usually less costly than the other types, and it can be repaired easily and track can be laid while under traffic: Where the bearing value of the soil is low, or if the vehicular traffic is heavy, the use of one of the other types is advisable.

Either the solid concrete or the concrete slab sub-ballast construction is well adapted for use on heavy traffic streets or on subsoils of low bearing value. The first cost is high but maintenance costs are relatively low. This type of construction is difficult in narrow streets as cars must be re-routed during construction. The slab construction is growing in favor. It affords somewhat better drainage and also permits re-surfacing without any disturbance of foundation slab.

Steel ties have been used with more or less success in the past but the use of wood ties is so general that no alternate specification was made for steel ties. There are many good solutions for preserving ties and several accepted methods of application, which fact makes detailed specifications impracticable. The use of treated ties in street railway track has not become general in so much as


10'-2" TRACK CENTERS
4'-8½" GAGE
5'-5½"
4'-8½" GAGE
PAVING TO BE ½" BELOW HEAD OF RAIL
GRADE LINE
CITY PAVING
PAVING TO BE ½" ABOVE LIP OF RAIL
STANDARD TIE ROD 2"×⅜"×5'-0"
PAVING AT RAIL TO BE ½" BELOW HEAD OF RAIL
SAND
½" CROWN
CEMENT MORTAR - PORTLAND CEMENT 1 PART TORPEDO SAND 3 PARTS
GRADE
CONCRETE
TIE 6"×8"×7'-0"
CRUSHED STONE
C
4'-0"
5'-1"
5'-4"
4'-0"
9'-4"
9'-1"
SECTION A-A
SECTION B-B
CROSS SECTION
GRANITE BLOCKS
SAND
CONCRETE:- PORTLAND CEMENT 1 PART TORPEDO SAND 3 PARTS CRUSHED STONE 6 PARTS
A
B
"E"
LONGITUDINAL SECTION C-C
END OF RAIL
LENGTH OF RAILS 35'-0" TO 60'-0"
END OF RAIL
EQUAL SPACES "E"
TIES IN THIS SPACE TO BE AS NEAR 2'-0" C. TO C. AS POSSIBLE
TIE SPACING FOR TRACK CONSTRUCTION TYPE NO. 3
NOTE:- SEE SPECIFICATION D-4
REVISED:
BOARD OF SUPERVISING ENGINEERS
CHICAGO TRACTION
TRACK CONSTRUCTION TYPE NO. 3
WOOD TIES IN CRUSHED STONE · 10'-2" TRACK CENTERS
DRAWING NO. 2-D-179
Aug. 19
Aug. 21

LENGTH OF RAIL IN. FT	C TO C OF TIES SPACE E	NUMBER OF TIES PER RAIL	LENGTH OF RAIL IN FT	C TO C OF TIES SPACE E	NUMBER OF TIES PER RAIL
35	23¼"	18	47	23½"	24
36	24"	18	48	24"	24
37	23¼"	19	49	23½"	25
38	24"	19	50	24"	25
39	23¼"	20	51	23½"	26
40	24"	20	52	24"	26
41	23½"	21	53	23½"	27
42	24"	21	54	24"	27
43	23½"	22	55	23½"	28
44	24"	22	56	24"	28
45	23½"	23	57	23½"	29
46	24"	23	58	24"	29
			59	23½"	30
			60	24"	30

2-D-179—TYPE NO. 3 TRACK.

ties embedded in concrete have been found to have a long life. The use of tie plates is contemplated in the specifications—they are inexpensive and serve to preserve the ties by distributing the pressure of the rail over a greater area, thus adding to the life of the track.

In the selection of rail, it must be borne in mind that it is important to have as much concrete above the ties as possible. A girder or high T-rail has been found most satisfactory and we find the heights of nine (9) or seven (7) inches in most common use. The nine (9)-inch rail permits the use of tie rods above pavement base and also lends itself more readily to an efficient joint.

The pavement base should be of concrete and should extend down to the bottom of the ties and beyond the ends. Rail filler under the heads of the rail and against the web should be used in all cases even where nose blocks are used. Nose blocks seldom have true ends which will fit tightly against the web of the rail.

There is a great diversity of opinion as to proper type of pavements for street railway right of way. The preponderance of opinion however, leans strongly to a block pavement. It probably will be agreed that granite pavement has given the greatest service, but it has very high first cost and does not have a smooth surface until worn. In some localities, its cost is prohibitive. For heavy vehicular traffic it is strongly recommended.

The Committee on Way Matters of the American Electric Railway Engineering Association has compiled considerable information on street railway pavement and presented a valuable report in 1914 and 1915. We abstract the following tabulation showing character of pavement between tracks as compiled from reports to that committee.

Concrete................	19.48	Miles	0.9	Per Cent
Asphalt.................	404.19	"	18.0	" "
Slag Brick (Scoria).......	49.67	"	2.0	" "
Macadam...............	86.05	"	3.8	" "
Granite Blocks...........	635.85	"	28.3	" "
Wood Block.............	84.41	"	3.7	" "
Brick...................	724.93	"	32.3	" "
Bituminous..............	37.27	"	1.7	" "
Asphalt Block...........	2.88	"	0.1	" "
Other pavement..........	196.24	"	9.0	" "
	2,240.97	"	100.0	" "

That Committee further concluded,

"First: There is a diversity of opinion among member companies regarding the use of T-rail in paved streets.

"Second: That granite or brick headers along the gage line, and under the head of rails seem to be mostly used.

"Third: That portland cement grout or asphaltic cement grout is the most desirable means of filling the space next to the rails.

"Fourth: That the tendency of vehicular travel to follow the tracks is about as heavy with T-rails as with other kinds of rails."

STANDARDS OF STREET RAILWAY TRACK CONSTRUCTION AND PAVING IN AMERICAN CITIES

City	Track Foundation Type	Depth Below Ties	Sub-grade Rolled	Under-drains	Successful Pavement	Unsuccessful Type	Rails
Norfolk, Va.	Solid concrete.	5″	Yes	Few	Sheet Asphalt.	Wood block.	7″ 122 lb. grooved girder L. S. No. 491.
New York City	Under ground trolley and stone ballasted.		No	No	Granite block—dry mortar bed—bitum.		7″ or 9″ grooved.
St. Louis, Mo.	Solid concrete.	6″		No	Cut granite block—grout filler—concrete base.	Asphalt, wood block and granite block on sand bed.	
Elmira, N. Y.	Stone ballasted.	6″		No	Brick, bituminous filler—1½′ sand-cushion on 5″ of 1-2½-5 concrete base.	Sheet asphalt laid between and against rails.	7″ 91 lb. Tee L. S. Co. No. 375.
Baltimore, Md.	Concrete slab sub-ballast—heavy car traffic. Stone ballasted—moderate car traffic. Solid concrete on steel ties—heavy car traffic.	6″ 6″	No	In dummy strip in few places	Granite block—cement or asphalt filler—heavy traf. Sheet asphalt between stretcher blocks—moderate traf. Vit. block—cement filler—mortar bed—moderate traf.	Vitrified block or scoria block as liners.	
Houston, Tex.	Concrete slab sub-ballasted 6″ slab.		No	Yes	Brick with grout or asphalt filler on 6″ concrete base.	Wood block.	7″ 80-lb. grooved girder.
Los Angeles, Cal.	Solid concrete, stone ballasted.	6″	Yes	Laid under each track 6″ x 8″			
Columbus, O.	Concrete slab sub-ballasted 8″ slab 1-2½-5 mix, steel ties.	9½″	Yes		Granite block, asphalt filler on 7½″ of 1-2½-5 concrete.		Grooved girder 122-lb. Lorain Steel Co.
Chicago, Ill.	Stone ballasted.	8″	Yes	No	Granite block—grout filler cement sand bed on concrete base.	Wood block.	129-lb. 9″ grooved girder.
East St. Louis, Ill.	Stone ballasted. Concrete slab sub-ballasted 8″ thick.	12″			Brick or granite block—asphalt filler, dry mortar cushion on concrete base.		
Allentown, Pa.	Stone ballasted.	6″			Brick—grout filler.	Bituminous.	7″ 116 lb. Lorain Steel Co.
Wilkes-Barre Pa.			Yes	No	Sheet asphalt, brick, asphalt block, wood block on 6″ concrete base.		9″ Trilby.
Brookline, Mass.	Stone ballasted.	6″		In wet soils	Granite blocks, grout filler, concrete-base; wood block, sand filler, mortar cushion.	Brick.	Grooved.
Kalamazoo, Mich.	Concrete slab sub-ballasted 8″ slab—3″ of gravel ballast.	11″		No	Brick on 1½″ sand cushion on concrete base.		110-lb. T.
Charleston, S. C.			Yes	No	Sheet asphalt on 5″ concrete base.		
Elkhart, Ind.	Solid concrete.	6″			Brick on cement sand cushion—grout filler on concrete base.		
Yonkers, N. Y.				Where found necessary	Small granite block bituminous filler concrete base.		9″.
Asheville, N. C.					Brick on concrete base.		7″ T
Lorain, Ohio	Solid concrete.	8″		On open Track	Brick—grout filler.		6″ T

The Committee believes that the matter of surface and subsoil drainage is of greatest importance. It is hoped that there will be full discussion on this subject.

J. L. Elliott, City Engineer, Indianapolis, Ind., gives the following:

The street railways here are privately owned and operated. The company at present pays for all paving of tracks but this point is now the subject of a new contract and may be changed soon.

Below are listed answers to your questions obtained from the street car company and our own experience.

(1) Brick, stone, wood block, asphalt.

(2) Granite stone.

(3) Wood block and asphalt. Wood block is objectionable owing to the serious distortion of the rails when the oil filler of the block is evaporated or lost. Asphalt is objectionable because car company has no plant to make minor repairs to pavement.

(4) Track construction consists of wood ties, using ordinary and screw spikes with tie rods spaced 8 feet center to center and welded joints.

(5) 7-inch tee rail, Lorain section 91–375, and 100-lb. A. R. A. type.

(6) Concrete base for both track and pavement, using cement sand cushion for both brick and stone pavement.

(7) Sub-grade is rolled where it is not of too sandy nature.

(8) Sub-drainage is provided where sub-grade is in clay such as conditions found in Brightwood and eastern sections of the city.

Surface drainage is taken care of by contour of street.

The climate of a locality has a great deal to do with the type of construction to be adopted. What would be good construction in the south would probably not be adopted by cities of the north. Also, type and weight and weight of cars govern the class of construction necessary.

P. L. Brockway, City Engineer, Wichita, Kans., offers the following:

Covering in order your points of interest, first as to types of pavement laid. One of the earliest in this city simply required the use of gravelly sand under the ties and between the ties, with paving brick of the earlier small size for the surface. This can scarcely be called a pavement at all and, of course, was not at all successful, and, by insufficient support to hold the track to grade and the brick settling more between the ties than over the ties, caused the surface to become impassably corrugated.

I might add that in our subsoil and climate conditions we do not have to make any special drainage for any of our pavement.

The next type of pavement used, consists of 12 inches of concrete with ordinary 6 x 8 wooden ties imbedded and with special rail blocks on the gage side of the rails and with brick blocks on the outside, the rest of the surface being standard sheet asphalt. Some of this pavement was laid as early as 1908 and 1909. This type of surface is not satisfactory because the vibration of the track loosens the asphalt surface from the brick, permitting the entrance of water and dirt, and causes the asphalt to gradually curl up and crack. This action becomes naturally more rapid so that it becomes very unsatisfactory from the standpoint of vehicular traffic. Fortunately we do not have very much of this type, most of it being ten years old and still in use, altho a small amount of it has become so badly disintegrated that it has been necessary to re-surface.

Of brick construction we have several miles, and a great deal of which has been in use for ten years or more, some of it carrying interurban traffic for a number of years. This pavement has proved very satisfactory indeed. There is six inches of concrete under the ties, which has proved sufficient to carry this type of traffic. On one occasion a few years ago a wash-out occurred on such a track which was not apparent on the surface. The free unsupported span was about thirty feet and street car traffic was continued without any interruption over this track without any apparent damage or danger.

We have never used anything but T-rail section and practically all of the track has been laid with special rail blocks. On these old pavements the rail was all new at the time the pavement was laid and of special section six or seven inches in height. The rails were joined with ordinary fish plates, and without any tie rods between the rails.

Practically the only maintenance required has been an occasional loose joint. Somewhat later, along about 1915 some old rails were relaid, part of which had the ends sawed off to get them square and true, and part of them without being so trued up. The track laid with the old battered ends soon began to kick the pavement out, as it was impossible to hold the joints. This damage was progressively from the joints thruout the length to the rail and showed conclusively that there can not be too much care taken to prevent hammering and pounding at the rail ends.

Later the practice has been to weld the joints, using an electric welder.

The later construction for use with light rail was adopted because of the impossibility to get the special sections during the war and has been kept up because of financial difficulties, using old 60-pound rail, about 4¾ inches in height. It is not expected to be permanent, but it was thought that it would last from 5 to 10 years. The chats used for ballast are screened from the flint mines in the Joplin district. It is expected that when it becomes necessary to replace the tracks, higher section rails may be obtained and the chats removed and the ties set on down to the original concrete base and imbedded in concrete.

I might add that, while it is outside of your inquiry, we have used practicaly the same pavement as this second described above for industry tracks for steam roads, the only difference being that the concrete was laid 18 inches thick instead of 12 inches, and that light rail was used for an inside guard rail, rather than the special rail blocks.

This type of pavement has been used here ten years with entire satisfaction, both to the railways and the city traffic, and has been adopted as the standard of the Santa Fe in this territory.

We have not yet satisfied ourselves on high-speed heavy traffic steam roads, nor on crossing frogs. I have induced some of the railways to try a type of surface here which I hope will prove satisfactory to both of us and not be too expensive. It is a design which I worked out myself, but time alone can tell whether it is successful, so that a discussion of it would probably be premature.

Julius Adler, Deputy Chief, Bureau of Highways, Philadelphia, Pa., makes the following contribution to the discussion:—

From the standpoint of the city of Philadelphia, the matter of proper street railway track construction and paving adjacent to same is a very live subject but not one on which we are prepared to make positive statements concerning the correction of present defects.

As to the matter of types of pavement which have been laid adjacent to rails at one time or another in this city, practically every type has been used including sheet asphalt, vitrified block, wood block and granite block, but of these we have had no general success with any type except granite block for use immediately adjacent to the rails.

Recent track construction in Philadelphia consists of the 9-inch high trilby rail, laid on 5″ x 9″ x 8′ long ties spaced approximately 2 feet center to center. Specifications of this Bureau provide in all cases for concrete to the bottom of the ties for their full length. As a general thing, the track foundation is the existing natural subgrade material and a marked difference can be noted between sections of the city where the subgrade is gravelly and where it is a straight clay. On very recent track work the local traction company has placed under the ties at crossings only (which have been by all means the most frequent cause of failure of track paving) a bed of crushed stone screenings with a view of producing better subdrainage conditions at these points. These installations are so recent, however, as to make it impossible to judge the extent of benefit which may be derived.

As above indicated, standard construction in this city at the present time consists of either new or redressed granite block between the rails and in the dummy and new granite block runners where the shoulders are paved with either asphalt or wood block, with concrete extending to the bottom of the ties. This type of construction has been used for about ten years but in the meantime other variations such as the laying of both wood block and asphalt adjacent to the rails have been tried out from time to time with but little success.

W. W. Southgate, City Engineer, Nashville, Tenn., says in part:

I call your attention particularly to the type of construction wherein the Railway Company uses macadam tamped directly under the rails and ends of the ties and then wrapped up in concrete underneath and between the ties and over and around the macadam. This type of construction affords considerable resiliency under the ties and thus overcomes the tendency of the rails to corrugate when bedded down directly on rigid concrete foundation and also eliminates to a very considerable extent the tendency of the bottom flange of the rail to crush down the wood fiber of the ties and to cut into the same.

Another advantage of this type of construction is that when the macadam is tamped under the ties, traffic is thereupon turned over the track and allowed to run for a day or two and thus to develop and reveal any ties that may be either suspended or that may not thoroly tamped up. The screenings passing thru a ½-inch mesh are excluded from the macadam and the coarser macadam is used for this ballast. The concrete is mixed rather sloppy in the proportion of about 4½ standard bags of portland cement to 15 cubic feet of limestone screenings,—instead of sand, and 24 cubic feet of crushed limestone passing thru a 2½ inch mesh and retained on ½-inch mesh screen.

Traffic is turned off the track for about twenty-four hours after concreting. The sloppy concrete penetrates to a considerable extent into the voids in the macadam and thus the change in the foundation from concrete base to macadam is accomplished by a somewhat gradual gradation and is not abrupt. I have seen tracks concreted under traffic using this type of construction when necessities required the same, and a good stable foundation was attained thereby. Of course it is better to keep the traffic off during concreting until it has at least attained a good stiff set, but if conditions are such that this cannot be done, then by using this type of construction, successful concreting of the ties and road bed can be accomplished.

This type of construction has been used in this city for the past five or six years. The results have been excellent and tracks constructed under this method more than five years ago and under rather severe traffic are standing up well today.

H. C. Benaugh, Engineer of Maintenance and Way of the Nashville Railway & Light Co., should be given credit for the novelty and excellent characteristics of this manner of constructing combination concrete and macadam foundation for street railway tracks.

George H. Norton, City Engineer, Buffalo, N. Y., describes the methods of street railway track construction in vogue in that city.

Buffalo has approximately 223 track miles of street railways owned by two companies, 215 by one and 8 by the other. Practically all of which is the 9″ girder type as T-rails in the paved portion of our highways are prohibited by city ordinance on account of the difficulty of maintenance due to vehicle traffic ruts adjoining the rails, and the T-rail not being of sufficient depth to permit of the 7″ stone paving blocks on the 2″ sand cushion above ties. I will answer in the order your letter indicates:

Types of pavements laid: There are five types of pavement in general use with following mileage: Asphalt 4 miles; toothed asphalt 8 miles; block stone 160 miles; 2nd class stone, 32 miles; brick, 10 miles; with about 1¼ miles of macadam and ½ mile of wood block. This latter is on viaducts carrying streets over railroads where the bridge floor depth did not permit of 9″ girder rails and 5″ girder rails were used and the space paved with 4″ wood block. Brick also has been used in this way.

Asphalt Type. Where this pavement is laid between and outside of the rails, it is no longer favored by this city due to high cost of maintenance and this is the remaining four miles of what was originally about 20 miles in 1909.

Toothed Asphalt is now used only on the outside of the outer rails where the remainder of the pavement outside the track portion is asphalt. It is not favored between the rails and tracks but is preferred on account of the toothed joint instead of a straight joint between the block stone of the track portion and the sheet asphalt roadway.

Block Stone comprises 6″ concrete base, 2″ sand cushion, and 7″ dressed sandstone paving blocks. This is the type preferred both by the railway company and the city, due to the uniformly even wear of these blocks under traffic. Portland cement grout 1 to 1 is used.

Second Class Stone, is also a sandstone paver laid on sand base, but not longer used except for maintenance of old railway paving. A greater variation in dimensions is allowed for these blocks and they are not dressed as carefully as the Block Stone type.

Brick comprises the usual brick pavers laid on 1″ sand cushion with 6″ concrete base.

As stated above our most successful type is the dressed sandstone block with 2″ sand cushion and 6″ portland cement concrete base composed of either clean gravel or broken stone in proportions of 1 of cement to 8 of other aggregate.

Unsuccessful pavements would include asphalt directly adjoining the rails; second class stone principally on account of being laid on sand base, and toothed asphalt when laid between the rails.

The track construction preferred both by the city and the railways is locally known as "Type A" and comprises 9″ girder rail with screw spike on to 6″ x 8″ x 7′ wood ties spaced 2′ apart. Untreated long-leaf Y-P ties 90% heart are preferred by the local railway company on the theory that the best No. 1 grade of tie is preferable over a treated lower grade and to treat the No. 1 grade is not warranted on account of the expense.

This Bureau has not gone into the merits of treated over untreated ties.

Between the ties is a 6″ course of portland cement concrete in the proportions of 1 to 8 as described above for block stone paving base. Under the ties is a 2″ course of 1¼″ stone for tamping and drainage purposes. This course facilitates the relaying of track and pavement above without disturbing the concrete sub-base, which is also a 1 to 8 mixture 8″ thick and extends to the outer limits of the railway occupations, i.e., 2 feet outside the outer rails which, under the franchises and the New York State Law, the railways are required to pave and maintain. In double track occupations, midway between tracks and under the sub-base in an 8″ x 8″ trench is laid a 4″ drain tile surrounded with 1¼″ crushed stone. There are 3″ x 3″ vertical "weep holes" spaced 10 ft. apart also filled with 1¼″ crushed stone connecting the drain tile with the 2″ tamping course above. The drain tile is connected to the track drains or to street drainage receivers at the curb lines.

Rail Sections, for a number of years past the local railway has used the Lorain Steel Co.'s 124–432 9″ girder open-hearth steel rails. Previous to that 140-lb. San Francisco section, a 96-lb. section and a 138-lb. Buffalo section had been tried. The 124-lb. rail approved has a 2¾″ tread with top of groove ⅝″ below top of tread.

Preparation of sub-grade. After excavation to required depth, the sub-grade is rolled with a 10-ton roller and defective places replaced with good filling.

Drainage is described under track construction.

No specifications have been accepted by the city for track construction other than as indicated on the prints for track construction and rail section which have been approved by the

Department of Public Works. It has been our observation that track construction as described will last from 12 to 20 years, depending on kind and volume of traffic, without requiring entire renewal. The local company operates some heavy three-car interurban trains and I would estimate the average track life for such between 12 and 15 years before complete renewal.

About 1900 the local railway company entered into contract with the city to use the standard stone block pavement in its track space whenever a street was repaved and to complete all its track within 15 years but has failed to fully meet this arrangement.

Julian Montgomery, City Engineer, Wichita Falls, Tex., describes briefly construction in that city.

1. Types of pavement laid in this city are, wood, concrete, and bitulithic.

2. The most successful types are bitulithic and concrete.

3. The unsuccessful is the wood block pavement.

4. The old track construction used consisted of rather shallow base with wood blocks or concrete surfacing. The present track construction consists of one-course 1:2:3 concrete.

5 The section of rail being used in construction now under way is a 4″ rail.

6. The older pavement in track is in bad condition due to the flimsy construction. Nearly every rail joint is loose.

7 The present construction calls for a concrete foundation.

8 The sub-grade is rolled or tamped before the concrete is laid.

9. Practically all of the track is adjacent to the storm sewer.

10. Steel ties are being used in some street-railway construction now under way. These ties are placed so close together that they virtually act as reinforcing bars under the concrete.

The construction types used by the Public Service Railway Co. of Newark, N. J., are described as follows by Howard H. George, Engineer of Maintenance of Way.

This Company operates close to 900 miles of track, of which approximately 630 miles is in paved city streets. This paving is sub-divided roughly as follows: macadam 142; stone block, 414; asphalt, 19; brick, 30; wood block 25.

The most successful type of pavement for conditions such as exist on this property is stone block cut to certain specifications and laid on an adequate concrete base. I am sure the fact that it constitutes two-thirds of our total paving will amply bear out the truth of this statement.

The most unsatisfactory types are, as a rule, asphalt and wood block, with brick next and macadam last. Of course the latter type is not considered as a permanent type of pavement and there are certain traffic and street grade conditions which prohibit its use, but still it must be considered along with the rest. We never lay the first three types mentioned from choice.

Our experience with asphalt laid directly against our rails is that it soon crumbles and disintegrates along the rail and the remainder of the pavement rapidly fails as a natural result. As to brick pavement, we have found that the texture of the brick furnished is very seldom uniform, some being burned harder than others. The result is that vehicular traffic soon develops these "soft-spot areas" in the pavement and holes soon are formed. It is believed that this is an inherent defect in the process of manufacturing brick that cannot be overcome. It is not so serious in brick used for building construction, but is very serious in the case of paving brick.

In the case of wood block, on installations made to date on this property, there has been a marked tendency for the block to absorb water and swell, this causing the block to raise and destroy the paving surface, or, where the blocks were laid with sand joints moisture has penetrated to the cushion and the action of frost accomplished the same result. Occasional cases have been observed where wood block has given satisfactory service as far as wear is concerned, but both asphalt and wood block in street railway tracks are subject to the same serious objection from the street railway man's point of view, in this part of the country, that is, they are very slippery in wet weather and during the winter, offer no foothold for horses. The result is frequent delays to passenger service because of team down on our tracks. This is very noticeable on such streets as have been paved outside our tracks by the municipality with either of these types of pavements, while our track space is paved with granite block. Teams will almost invariably pull over in our track space when the rest of the street becomes too slippery for driving, and our schedules are thus seriously interfered with.

In adopting any type of track construction, local conditions must be considered. No single standard has ever been found up to the present time that would either satisfactorily or economically meet the requirements of every case. You will note that we invariably call for 6 inches of stone under our ties and that the latter are wood. We ordinarily purchase long-leaf yellow pine ties, sound and square edge quality, and creosote them with 10 lb. coal-tar or water-gas-tar creosote oil per cubic foot, using the full cell pressure treatment. Concrete is placed between the ties and to a height depending, of course, on the type of pavements to be laid. We are using two types of rail, one being a 7″ grooved girder section, weighing 116 lb. per yard, and the other being a 7″ tram, weighing 101 lb. per yard. We also lay some track in paved streets where permitted to do so by municipal authorities, with 80-lb. A. S. C. E. section tee rail. We either install brace tie plates on every other tie or use a tie rod every 6 ft. of track and sometimes a combination of the two.

Where practical to do so, we first roll the sub-grade and also the ballast before ties are laid. This develops any soft spots and affords the opportunity to fill and compact same. We have very few sub-soil conditions where drainage of sub-grade has been necessary, but where this has been done a trench is dug between the rails or between the tracks in which is placed a 4″ tile pipe and then covered with cinders or broken stone, the pipe being connected into the nearest sewer manhole.

We do not claim that this construction will give the best results for all conditions. For instance, on properties where the sub-soil is wet clay and difficult to drain properly, it is often found necessary to install a concrete mat under the track, but this is not usually true.

This company has never experimented with a rigid type of track construction. It is our contention that a certain amount of elasticity is necessary in the roadbed to produce the best results. Our conclusion, as a result of study of the experience of some other companies, has been that rigid construction usually aggravates joint troubles and rail corrugation and makes for a noisier riding track.

I wish to emphasize the important point in connection with our experience of many years with street railway track construction, i.e., we are in favor of stone ballasted track construction with wooden ties and paved with some form of stone block, preferably specification granite, with cement grout joints. While this type of pavement is more expensive in first coat, its annual maintenance cost is very small and its ultimate salvage value is very large, as it can usually be reclipped and relaid with a few extra block, producing a pavement as good as new. This is not true of any other type of pavement.

The following report on street railway construction in Bridgeport, and other Connecticut cities, St. Joseph, Mo., and Cleveland, O., is furnished by Manley Osgood of Ann Arbor, Mich., and was prepared for the Detroit Bureau of Governmental Research. Comparisons are made with Detroit practice.

The type of street railway track construction and pavement which has become standard with The Connecticut Company, was seen in both Bridgeport and New Haven, and in one or two smaller communities on the main highway between New York and Boston. Such construction has been in use in these localities since 1914. One section seen in Bridgeport has been in use for approximately one and one-half years, carrying very frequent street car movements and all of the truck and automobile traffic of the New York and Boston post road. It was, practically, in as good condition as when first opened to traffic. The Engineer of Maintenance of Way for the Connecticut Company in this section was interviewed, and he explained fully the method of construction, the theoretical advantages, and the success of this type of construction. The committee inspected the steel ties which have been adopted as their standard, and a section of rail approximately four feet long, with the concrete adhering to the web on both sides. Altogether several miles of this type of construction in the various localities were viewed. All track was in good condition and without any longitudinal cracks whatsoever.

Under the present Detroit practice a concrete foundation, not less than eight inches thick, is constructed below and supporting the track structure proper. There is no bond or connection between this foundation and the track construction. Wooden ties are used and the rails are placed upon them with the web vertical. Ties are ballasted on the top of the concrete foundation with a dry mixture of sand and cement, and concrete is poured about them and about the base of the rail up to the proper height to allow for the placing of standard brick pavement.

In the modified Connecticut practice, steel ties are to be used and so deformed at the end that the rail is slightly canted. This canting is made to correspond with the cone of car wheels adopted as standard in such a way that the top of rail is parallel to the cone of the wheel and the load from the wheel is transmitted to the rails parallel with their web. The entire steel tie and rail is imbedded in concrete. The rail joints are welded with a plate on each side to support the head of the rail at the joint. In this type of construction the track structure consists of a re-inforced concrete slab, bearing direcly upon the soil beneath it. The width of bearing per linear foot of track, or per unit of load supported is equal to or can be made greater than with the foundation used in the present Detroit practice.

In this type of construction two things are believed absolutely essential—

First, steel ties must be used.

Second, the concrete must be brought to the head of the rail, the entire depth of concrete being placed in one operation.

Wooden ties entirely encased in concrete soon crack and split the concrete. This is due to the difference in expansion of the two materials. Steel encased in concrete, as is done wherever re-inforced concrete is used in building construction, does not act in this manner because the expansion of the two materials is approximately equal. The steel tie which is believed fundamental to this type of construction acts as re-inforcing and in a re-inforced concrete slab, which is integral with the track construction itself, to support the load imposed upon the track. Unless the concrete in the modified Connecticut type of track construction is brought to the head of the rail, a street car passing along the railway will set up certain lateral vibration in the rail that will separate it from the concrete on either side, allowing moisture to penetrate between the rail and the concrete in the opening thus established. This is believed to be one of the greatest weaknesses of the present Detroit construction.

These two types of track construction have been compared by a prominent Detroit engineer to former and present building construction practice. In the older type of building construction the framework of steel was constructed and each floor was placed on top of its steel support so framed. In the more modern type of building, the steel frame work is built into and is an integral part of the floor which it supports.

Paving Surface. In the track construction seen in the Connecticut district, the concrete construction was of the Hassam type and was used as a paving surface. This Hassam pavement is constructed by placing the particles of stone used as concrete aggregate before mixing them with the sand and cement mortar. These particles of stone are rolled into place until each particle has a firm bearing against its neighbor particle, and until each surface particle has a flat face up. The sand and cement grout is then poured, under pressure, into the opening or vacant spaces between these particles of stone. The sample of this type of construction which was seen in New Haven showed that thoro penetration was secured and a very excellent concrete obtained. This type of paving surface might be sufficient for traffic in some localities where the new municipal street car lines are to be constructed, but in other localities where sheet asphalt surface is desired, this type of construction might be adapted to such surface, without impairing or affecting its strength and efficiency. Where sheet asphalt is to be used as a surfacing material, concrete mixed in the ordinary manner could be used instead of the Hassam concrete used in Connecticut. This would leave no doubt concerning the penetration of the mortar to the bottom of the slab.

Comparison of Costs. The adoption of the modified Connecticut standard for the lines to be built in Detroit would save the eight inches of concrete, over the entire width of the road bed, that is now placed beneath the D. U. R. tracks. This saving of aggregates, using the prices recently bid for the track work which has already been awarded to contract, approximately $40,000 per mile of double track, or approximately $20,000 per mile of single track. The cost of paving surface would be no greater. The concrete would need to have a larger proportion of cement, which might cost $1,300 per mile of single track more than for the concrete used in the present Detroit standard.

Other Factors. Track constructed according to the proposed modification of the Connecticut standard is rigid and does not give under the rolling and car equipment.

Particular attention was paid, in viewing the track, to the rail joints. These were uniformly, where this type of construction was built with new rails, in excellent condition, and cars passed over them as freely as over the mid-portion of the rails and with no more vibration in either rail or car.

St. Joseph Practice. The St. Joseph Street Railway Light & Power Company is a subsidiary of the Cities Service Company of New York. The track being built in St. Joseph by this company is over a low, marshy section of the city adjacent to the

Missouri River. The sub-soil is a black, murky clay. The track carries 37,000-pound, double-truck cars, running at times very frequently. It was in order to meet this soil condition that the type of construction under consideration was developed.

International steel ties are being used in this construction. Excavation is being carried about 19 or 20 inches below the top of the rail. Approximately six inches of crushed stone is put in the bottom of this excavation and rolled. The ties and rail are put in place and blocked to proper grade and line. Concrete is then poured under and around the ties and up onto the web of the rail to a total thickness of approximately ten inches, leaving the top of the concrete about four inches below the top of the rail. This four inches is paved with a one-inch sand and cement cushion and three-inch brick. Rail joints are thermit welded. There are four inches of concrete under the bottom of the steel tie and above the crushed stone sub-base, or blind drain. The first of this type of construction in St. Joseph was just being installed so no conclusion as to the service which it will give could be drawn from experience.

The St. Joseph engineers, working separately from any other investigation that we have encountered, have endeavored to solve difficulties in a way very similar to the modified Connecticut standard. The fundamental idea was to build a track as rigid as possible in which the concrete poured about the tie and the base of the rail would be sufficiently strong to carry the load imposed upon it without the use of concrete foundation underneath the track construction proper. The use of concrete foundation underneath the track construction proper had been rejected on account of its great expense.

Cleveland Practice. Cleveland has 150 miles of track constructed with steel ties and 121 miles of track constructed with oak ties. The earliest use of steel ties was about 1908. Both International steel ties and Carnegie steel ties have been and are now being used altho in all cases an International steel tie is placed under each rail joint. The deepest parts of excavation which occur underneath each rail are carried approximately 19 inches below the top of the rail. The earth is mounded between rails and between ties however, so that in the center of each panel formed by rails and adjacent ties the concrete does not extend below the elevation of the bottom of the tie. Underneath each tie, however, there is approximately six inches of concrete, and underneath each rail there is a longitudinal concrete girder approximately 12 inches deep. The ties, in this method of construction, are entirely encased in concrete. The top surface of the concrete is brought approximately to the base of the rail and carries on top of it a sand cushion and five-inch granite block pavement.

Cleveland's sub-soil conditions are mainly sand, altho in some cases clay deposits are encountered. No different form of construction is used where such clay pockets are encountered than the standards used for the sandy soil conditions. In only one or two isolated instances, and these instances for experimental purposes only, has Cleveland ever constructed a concrete foundation underneath the track structure proper.

In Cleveland, rail joints are welded with a plate on each side of the web of the rail and supporting the rail head. This is the so-called "Lincoln" type weld, and the one used by the Connecticut company. Previous to electrically welding plates on each side of the rail joint, Cleveland used the same type of joint but riveted the plates in place thru holes in the rail. They consider the electric welding of these plates to the rail to be better practice than riveting, which was used before the electric welding art was advanced to its present stage.

The cars used in Cleveland have generally as great, and in some cases greater seating capacity than those used in Detroit. They are not, however, as heavy as the Detroit cars. The Cleveland engineer has made very considerable engineering studies of street railway track construction. He has used deflectometer measurements in making this study. From his experience and study he expresses himself very strongly in favor of the most rigid track construction possible where paving is to be laid.

In Cleveland, as in Connecticut, the rails of the street-car tracks are slightly canted, or tilted inward. This causes the load of the cars to pass thru the rail parallel to and practically thru the center of the web of the rail. It does away with the overturning pressure on the rail and the consequent crushing thrust on the paving adjoining the outside of the rail head. This removes one cause of paving trouble. It also causes uniform wear on the rail head.

Conclusions. In three separate locations—Connecticut, Cleveland, and St. Joseph, Missouri, three men working entirely independently have endeavored to solve track difficulties in much the same manner. One man was a railway engineer in charge of track construction and maintenance; another man was a civil engineer looking after the city's interests under a Taylor-plan agreement. The third was a man with considerable track experience in charge of street railway track construction and maintenance.

They have all come to the conclusion that where street paving was to be laid over and adjacent to street railway tracks, the track construction should be as rigid as possible. By eliminating the vibration in the track, they have all hoped to overcome many of their paving difficulties. The representatives of the Bureau have therefore reached the following conclusions:

1. That the type of track construction viewed in Bridgeport, New Haven, and in near by territory is decidedly less expensive than the type of track construction now used in Detroit.

2. That the results from the use of the Connecticut type of construction are sufficient to warrant the Detroit Street Railway Commission in making a thoro investigation thru competent railway engineers of the practicability of using this type of construction under Detroit soil and traffic conditions.

3. That aside from consideration of the expense and construction possibilities of the Connecticut type, investigation should be made of the effect of such a rigid type of track upon rolling equipment.

The following specifications are not presented for adoption in their present form, but more for the purpose of providing a basis for a final draft. We hope for a full and instructive discussion at the annual meeting, which will enable next year's Committee to draft specifications which will be acceptable to the Society.

PROPOSED SPECIFICATIONS FOR STREET RAILWAY PAVEMENTS AND TRACK CONSTRUCTION

I. *Excavation*

1. The contractor, shall excavate the space to be occupied by the tracks to a depth of — inches below finished grade. Any soft, spongy or otherwise defective material shall be removed from the sub-grade, and replaced with sound material.

2. The sub-grade, shall be thoroly rolled with a three-wheel roller weighing not less than ten (10) tons where practicable. In places inaccessible to the roller compression will be secured by tamping.

II. *Subsoil Drainage*

3. In all soils except sand, gravel or sandy loam, subsoil drainage shall be provided.

4. This shall be done by laying either four (4) or six (6)-inch tile pipe in a trench surrounded by crushed stone, gravel or cinders. The drain shall be laid under the center of each track or midway between tracks, as may be determined by the character of soil.

5. Provision shall be made for connections leading from the base of rails to the subsoil drains, at frequent intervals.

6. Subsoil drains shall be connected to the sewers by means of vitrified tile pipe, of a suitable size.

III. *Foundation*

7-a. Plain Ballasted Construction. The ballast shall be evenly spread in the trench so that, after being thoroly compacted with a three-wheel roller weighing not less than ten (10) tons, it shall have a minimum depth of — inches.

8-a Ballast shall consist of clean, hard, durable crushed stone or gravel graded so as to pass a two (2)-inch screen and be retained on a one-quarter (¼)-inch screen.

7-b. Concrete Slab Sub-ballast Construction. Upon the subgrade prepared as above described, shall be laid a portland cement concrete slab — inches in depth. The concrete shall conform to the A.S.M.I. specifications for concrete for pavement foundations.

8-b. After the concrete slab has set a layer of ballast shall be laid to a maximum depth of three (3) inches. Ballast shall consist of clean, hard, durable crushed stone or gravel graded so as to pass a five-eighths (5/8)-inch screen and be retained on one-quarter (1/4)-inch screen. Ballast shall be well compacted by tamping.

7-c. Solid Concrete Construction. Upon the sub-grade prepared as above described shall be laid a concrete foundation which shall be constructed integral with the pavement base. The concrete work will follow immediately after the surfacing and lining of the track. The final concrete shall be brought to a height — inches below the top of the rail and shall coincide with the grade established for top surface of pavement base. Concrete below and around ties and rails shall be thoroly rammed and tamped. If the engineer deems it necessary, cement grout shall be poured so that all voids will be filled. Care shall be taken in tamping under and around the tie and rail so that the surface and line of the track shall not be disturbed. In no case shall the ends of ties be covered by a board while placing the concrete.

8-c. The concrete shall conform to the A.S.M.I. specifications for concrete for pavement foundations.

IV. *Rails*

9. The rails used shall be of a type and weight which shall meet the approval of the engineer. The T-Rails shall comply with specifications of the American Society for Testing Materials. The High T-Rails and girder rails shall comply with the specifications of the American Electric Railway Engineering Association.

V. *Rail Joints*

10. Rail joints shall be modern bolted, riveted or welded joints. The joint selected shall produce the effect of a continuous rail. The type of joint and the method of making shall be approved by the engineer and be subject to his supervision.

VI. *Rail Fastenings*

11. The rail shall be brought to proper gage and fixed securely to ties by track spikes or screw spikes. Clips shall be used in all cases when screw spikes are used. The type and dimensions of rail fastenings shall be approved by the Engineer.

VII. *The Plates*

12. Upon each tie and under each rail shall be placed a tie plate. The size, type, and weight of tie plates and the method of fastening to the ties shall meet with the approval of the engineer.

13. When tie rods are not used, suitable brace tie plates shall be placed as directed by the engineer.

VIII. *Ties*

14. Wood Ties (untreated). All ties shall be either No. 1 white oak or ninety (90) percent heart long-leaf yellow pine.

15. All ties must be square edged and sound and sawed out of straight-growing timber.

They shall conform to specified dimensions, be out of wind, with sawed ends, and straight and parallel faces. Ties shall be free from splits, shakes, loose or decayed knots, or other imperfections which may impair their strength or durability.

16. The standard dimensions of all ties shall be six (6) inches in depth eight (8) inches in width and eight (8) feet in length. A variation from the standard dimensions of one-half (½) inch in depth and width and one (1) inch in length will be permitted, provided that not more than twenty (20) percent of ties under the standard dimensions will be accepted.

17. Wood Ties (treated). All ties shall be of long-leaf yellow pine, short-leaf yellow pine, loblolly pine, Norway pine, Oregon fir, cypress, white oak or red oak.

18. Ties shall conform to the specifications in paragraphs 15 and 16 as to quality and standard dimensions.

19. The air-seasoning of timber is preferred before steaming, but where sufficient time cannot be allowed for this fresh cut timber will be allowed to be substituted for treatment.

20. The character of the antiseptic solution and the method used shall be subject to the approval of the engineer.

21. The spacing of ties shall be not more than twenty-four (24) inches center to center.

IX. *Pavement Base*

22. After the foundation has been constructed, the track laid and brought to proper alinement and grade, the pavement base shall be laid. It shall be of concrete which shall conform to the A.S.M.I. specifications for concrete for pavement foundations. Concrete shall be thoroly rammed and tamped around ties and rails.

23. Care shall be taken in tamping around the tie and rail so that the surface and line of the track shall not be disturbed. If the engineer deems it necessary, cement grout shall be poured so that all voids shall be filled. In no case shall the ends of the ties be covered by a board while placing the concrete. Care must be taken to have the outside edges of the concrete base conform to the dimensions. The concrete shall extend from the bottom of the ties to a grade above the tops of the ties — inches below the top of the rail.

X. *Rail Filler*

24. The spaces under the heads of the rails and next to the webs shall be filled ahead of the pavement with portland cement mortar composed of one (1) part portland cement and three (3) parts torpedo sand. At the option of the engineer mastic may be substituted consisting of asphaltic concrete binder.

XI. *Stone Block Pavement*

25. The stone block pavement shall be laid with blocks at right angles to the rails. The pavement shall be laid one quarter (¼) inch below the grade of the rails. The quality, and size of the blocks, the mortar cushion, the method of laying and tamping shall conform in all respects to the specifications of the A.S.M.I. for stone block pavements. The filler used and the method of filling joints shall also conform to the said specifications.

26. Where a T-Rail is used, the engineer may require a special nose block to be used which will butt against the web of the rail and under the head.

VII. *Brick Pavement*

27. The brick pavement shall be laid with blocks at right angles to the rails. The finished surface of the brick pavement shall be one-quarter (¼) inch below the grade of rails.

The quality and size of brick, the sand cushion, the method of laying and rolling shall conform in all respects to the specifications of the A.S.M.I. for brick pavements. The filler used, the method of filling joints and expansion joints shall also conform to the said specifications.

XIII. *Wood Block Pavement*

28. Along both sides of each rail two rows of stretchers shall be laid. The stretchers may be stone or brick as may be determined by the engineer. The stretchers shall conform to the above specifications in all respects. Additional lines of stretchers may be used at the option of the engineer.

29. The wood block pavement shall be laid with block at right angles to the rails. The finished surface of the pavement shall be flush with the top surface of the stretchers. The quality and size of the wood block, material with which they are impregnated, methods of treatment, method of laying and rolling, filler, method of filling and expansion joints shall conform in all respects to the specifications of the A.S.M.I. for creosoted wood block pavement.

XIV. *Sheet Asphalt Pavement*

30. Stretchers along rails shall be provided as specified in Paragraph 28. The sheet asphalt pavement shall be laid so that the top surface shall be flush with the top surface of the stretchers. The character of the sheet asphalt pavement, the method of laying and rolling shall conform in all respects to the specifications of the A.S.M.I. for sheet asphalt pavements.

XV. *Portland Cement Concrete Pavement*

31. Concrete shall be laid so that the finished surface of the pavement is one quarter (¼) inch below the grade of the rails. The character of the material, method of mixing and laying,

reinforcement, method of finish and protection shall conform in all respects to the specifications of the A.S.M.I. for portland cement concrete pavements.

XVI. *Grade*

32. Where track centers are ten (10) feet or more, a crown of not less than three-quarters (¾) inch shall be provided in the dummy between tracks. The grade of the outer rail shall be one-quarter (¼) inch below the grade of the inner rail.

The report was accepted tentatively to be printed in the Proceedings and referred back to the Committee for final report next year. A vote of thanks for the report was also passed.

MR. WYSOR: I represent the American Electric Railway Engineering Association and we would like to request that no action be taken on this report at this time for we have not had an opportunity to consult and confer with the Committee of the A. S. M. I. and what we would like to do is to have a joint committee, a committee of the A. S. M. I. and a Committee of the American Electrical Railway Engineering Association to act jointly on these specifications. If it is in order I would like to move that a committee be appointed from this society to confer with a committee of the American Electrical Railway Engineering Association and work jointly on these specifications.

MR. TILLSON: I think there is no question, Mr. Chairman, that this Committee we appointed will be glad to confer as the gentleman suggests with these other gentlemen because we all want to get the same specifications.

CHAIRMAN HORNER: We will leave that to the Committee as the sense of the meeting, that they work with you the coming year.

MR. GEORGE: I believe our Secretary has communicated with both your retiring President and your Secretary, requesting that joint action be taken in preparing these specifications. We feel that we have so much in common, as long as we are the men who have to build the track and the men who have to pay the bills for both the construction and maintenance, that it would be to both your interest and ours to get together on this matter and draw up specifications that would have the backing of both the A. S. M. I. and the A. R. E. A.

CHAIRMAN HORNER: The matter has been in the hands of the Executive Committee and they have instructed the Secretary to take it up with the idea of securing cooperation during the coming year.

The next committee is the Committee on Standard Tests for Bituminous Materials, Francis P. Smith, Mr. Smith was absent, and Mr. Dow read the report.

The report will be found on page 331.

MR. HOWARD: I would suggest that as a number of the members of the Society undoubtedly have not access to the records of the A. S. T. M. that the wording of the tests be inserted in here, so that members of our Society may see what it is. These records are not public. They belong only to the members of the society and it is impossible for many of our members to see them. I would suggest the Committee insert the specifications referred to by these initials and abbreviations.

MR. CORSON: I have listened to all these specifications very attentively and not one word has been said concerning the backfilling of ditches and the restoration of street pavement. I would like to say for the benefit of the members present that on next Monday in my home town an ordinance will be passed to cover that particular point, based on research by the State Highways Department of Pennsylvania, trying to get some one definite feature by which we can maintain pavements after being cut for repairs or new connections by public utilities. I fully appreciate that where you have sand and gravel you can use the flooding process with excellent results but in my country, where we have shale and clay, flooding is prohibited by ordinance because of the fact that in flooding clay you get no solidity. We have incorporated in the ordinance also features by which inspectors shall be paid a fee based on the number of square feet opened and the appointment of the inspector; also where side ditches are insecure or where they are of such a nature that they will not sustain a concrete arch, what would be termed the timbering is allowed to stay in. The backfilling is done in such a manner as to form a center for the concrete arch that is to sustain the slab which is to support the pavement. We have tried it out experimentally for the last two or three years with excellent results. Over the top of the arch is to be constructed a slab of whatever depth is necessary to support certain pavements all of which are specified in the ordinance. There has not been any discussion in this society since I have been a member of it on the subject of the back-filling of ditches and I would like to have some discussion after this on the part of the members.

(By letter)—The ordinance was passed finally as referred to and for the benefit of several members who asked me for copies, I present it herewith.

A supplement to an ordinance entitled "An ordinance concerning and regulating street excavations and deposits," enacted April 1, 1913, regulating the back filling of transverse and longitudinal ditches by corporations, firms and individuals obtaining permits to make all excavations in the highways of Norristown, and to provide for the fees for inspection.

The Burgess and Town Council of the Boro of Norristown, in Town Council assembled, hereby ordains and enacts:

Section I. From and after the enactment of this ordinance in addition to the requirements provided in Section VII of the ordinance of April 1, 1913, to which this is a supplement, corporations, firms and individuals receiving permits to make excavations in the highways of the boro, shall be required to back-fill all trenches to a height as hereinafter directed in Section III of this ordinance, and such back-filling shall be rammed so as to form a crown or arch over the fill, and on top of this crown shall be constructed and laid a concrete arch of the thickness as shall be determined by the boro engineer, the haunch or spring line of which arch shall extend on each side over the trench or ditch six inches. Over the crown of the arch thus constructed shall be placed a concrete slab of the thickness of not less than six inches, the width of this slab being wide enough to entirely cover the width of the ditch and the extra width of six inches on each side of the ditch. This slab is to be constructed only after the concrete arch has been allowed to set for a period of not less than 72 hours; or the space over the arch may be filled solidly with concrete up to the required height as is given in Section III hereafter.

Section II. If the sides of the ditch are too soft or too weak to support the concrete arch, then planks 2 inches thick and not less than 9 inches wide shall be laid longitudinally on each side of the ditch, properly braced to support the weak sides, said braces to be not over 3 feet apart centre to centre.

Section III. In all such excavations in the highways of the boro the arch and slab to be constructed over the back filling shall be placed as follows:—

(a) Where the surface of the street is paved with Warren Brothers Bituminous Macadam, Bitulithic, Tarvia or Ugite, Macadam the crown of the arch and slab shall be so constructed as to be six inches below the surface or level of the street at its highest point.

(b) Where the surface of the street is paved with concrete the crown of the arch shall be so constructed as to be level with the bottom of the concrete base under the adjoining pavement.

(c) Where the surface of the street is paved with brick the arch and slab shall be level with the bottom of the concrete base under the adjoining pavement.

(d) Where the surface of the street is paved with Belgian blocks, the arch and slab shall be so constructed as to be level with the bottom of the sand cushion under the adjoining pavement.

Section IV. The boro engineer is authorized to issue such permits upon the advanced payment made by the applicant to the municipality, for inspection charges based upon the kind of the pavement thru which the excavation is to be made, as follows: On the pavement specified in clauses "(a)" and "(b)" of Section III the sum of five cents per square foot of area, and in the pavement specified in clauses "(c)" and "(d)" of Section III, the sum of ten cents per square foot of area.

Section V. The applicant for such permit shall give to the boro engineer the information as to the kind of pavement thru which the excavation is to be made, the outside dimensions of the proposed opening upon the basis of which the inspection charges are to be made. Should this area be greater than that given to an applicant, at the time of the issuance of the said permit, upon measurements made by the boro engineer, the applicant shall pay the boro for such excess, upon the basis specified in Section IV herein.

Section VI. It shall be unlawful in any back filling of the trenches to raise the crown of the ditch above the surface of the other part of the street, and the part of the street over the said back-filling must be paved by the holder of the permit within ten days after the completion of the back-filling with the same kind of material as the other part of the street is paved with; and upon failure to do so the boro may do such repaving at the cost of the party to whom such permit was granted, to be collected by suit in the same manner as claims of like nature are by law recoverable, together with the costs of suit.

Section VII. It shall be unlawful to grant any permit to make excavations in any street for installing service pipes for gas and water, sewer connection or other purposes where the said street has been paved or resurfaced with a permanent pavement or with Tarvia macadam, for the period of five years after such repavement, unless permission to do so be specially granted by the Council of the Boro.

Section VIII. All provisions for indemnity, penalties, etc., contained in said ordinance of April 1, 1913, to which this is a supplement, shall likewise apply to this supplement as fully as if set forth herein, and no part of said ordinance is hereby repealed or modified excepting as herein contained and as are inconsistent herewith.

Section IX. All ordinances or parts of ordinances inconsistent herewith are hereby repealed.

The convention adjourned at 6 p. m.

Friday Morning, October 28, 1921

The session was called to order by President Compton at 9 a. m.

Professor A. H. Blanchard presented the report of the Committee on Standard Tests for Non-Bituminous Materials, which will be found on page 332.

He also presented the report of the Committee on Traffic and Transportation which, with the discussion thereon, will be found on page 333.

GOTTFRIED LINDSTEN, Member of Minneapolis City Council: I noted early in the session that the Mayor of Baltimore dwelt very lucidly and very sympathetically on the unemployment situation and that theme has somewhat run thru the fabric of the entire discussion, more or less.

In the Minneapolis City Council we introduced a resolution some time ago whereby we would try to devise ways and means to recover the deadhead logs embedded in the Mississippi River, saw them up and apportion them for fuel to the needy citizens during the winter. This proposal was to absorb some of the unemployment and give fuel to people unable to buy it in these days of high-priced fuel.

This involved an engineering feature,—that of using the equipment of the Water Works department. In this trip to Baltimore I was one of the delegation; I was also sent to Washington with special letters of introduction to the War Department, asking the War Department for their co-operation; at least not to interfere with our activity in gathering these logs that had been sunk in the river bed from logging days extending back the last two decades.

I was told that the War Department considered these logs an obstruction, and that unless the city interfered with any construction work the War Department might have in the Mississippi River, thruout this district, we would be welcome to the logs. We were quite encouraged to gather these logs, and were advised to get a bill of sale from the logging companies for these submerged logs, and it was pointed out that our fight was not with the War Department but with the logging companies or whoever owned these submerged logs.

Brig. Gen. Taylor further said that what was true of Minneapolis and vicinity in regard to sunken logs in the Mississippi River was also true of many southern cities where logging has been an industry for years.

I submit our Minneapolis idea of recovering logs for fuel, and to reduce unemployment somewhat, to this convention, as being in line with the unemployment theme that has been a prime topic of discussion.

Raymond L. Winslow's paper on The Present Aspect of the Paving Brick Industry and the Relations of the Manufacturers to Municipal Engineers was read by Acting Secretary Folwell. It will be found on page 323.

Robert Ridgway presented his paper on Subways for City Transportation, which was interestingly illustrated by stereopticon. It will be found on page 339.

Dr. J. E. Greiner of Baltimore discussed The Port and the Municipality as printed on page 358.

Prof. A. N. Johnson read his paper on The Engineer Student and Public Service which will be found with discussion on page 364.

The report of the Sub-Committee on Snow Removal was presented by Chairman T. F. Sullivan. See page 368.

E. E. Butterfield's paper on The Properties of Mineral Aggregates Available in the Metropolitan District was presented. It will be found on page 311.

J. Frank Crowther's paper on School Architecture was read by Acting Secretary Folwell. It will be found on page 387.

The paper on the Maryland Casualty Buildings, by Otto G. Simonson was printed and given to those who took the Friday afternoon inspection of that development. See page 374.

Reports of representatives in other organizations were made as follows:

Committee on Clay and Cement Sewer Pipe of the American Society for Testing Materials, by W. W. Horner, delegate.

Since the assignment of a delegate to this society there has been a call for only one meeting, attended by Mr. Potter as an alternate. He attended and found several matters of interest, but the general interest in the subject of sewer construction which developed in the Sewer Committee prevented any detailed report by Mr. Potter at this time.

George F. Fisk, delegate on the committee on Brick of the A. S. T. M. reported:

Your representative on Committee C-3 on Brick, American Society for Testing Materials, respectfully submits the following report:

Your representative attended the meeting of Committee C-3 A. S. T. M. at Asbury Park, N. J., on Tuesday June 21, 1921. At this meeting the Chair was authorized to appoint a sub-committee to study the chemical requirements for sewer brick in order that the tentative specifications might be made definite rather than being left to be settled by contract. The Sub-committee on Nomenclature reported that they were satisfied with the definitions of surface clay, fire clay, and shale as contained in the tentative specifications for sewer brick. Chairman Boyd of the Sub-committee on Promotion of Knowledge of Brick Work presented a report which was of great interest and importance to the committee.

A standing committee on paving brick was created to take care of any criticisms of the paving brick specifications which might be received. Your representative was appointed as a member of the Sub-committee on Sewer Brick.

The report of H. Eltinge Breed, representation on two cement and concrete committees of the A. S. T. M., was made by Acting Secretary Folwell as follows:

Having been appointed as delegate from the American Society of Municipal Improvements to serve on two committees, I submit the following report.

Committee C-1 on cement has held no meeting and taken no action since my appointment.

The meeting of Committee C-9 on Concrete Aggregates is scheduled for November 1. The purpose of the meeting is to consider what action the committee will take in respect to the report of the joint committee on Standard Specifications for Concrete and Reinforced Concrete, with which committees of the following societies are affiliated:—

American Society of Civil Engineers.
American Society for Testing Materials.
American Railway Engineering Association.
American Concrete Institute.
Portland Cement Association.

At this meeting, the committee will discuss definition of terms, quality of concrete, materials, proportioning and mixing of concrete and its consistency, and the proportions for concrete of given compressive strength at twenty-eight days.

Any suggestions that will guide your delegate in his action will be gratefully received.

Mayor Broening reported regarding the Mayor's Conference held during the week and the cooperation possible with this Society as follows:

It is with some diffidence at the closing of your Convention that I again appear before you, this time, however, as one representing the Mayors' Conference. When the Committee in charge of the arrangements for this Convention conferred with the Mayor it occurred to him that there ought to be a closer cooperation between men engaged in a work of this character and the heads of their municipalities, and that Mayors and chief executives and managers of cities ought to have their attention directed to the necessity of encouraging the technical men of their municipalities in associating with and attending a convention of this character, and with that in view, to suggest that we invite at the time of your convention, a conference of the Mayors of American municipalities and of municipalities in the adjacent country on the North. This was done and we believe productive of great good. While many mayors have been unable to attend we have the assurance thru the technical men coming as the representatives of the municipalities, many of them as the personal representatives of the chief executives, of their interest in this convention and conference. We had fifteen mayors here, tho some thirty agreed to come but at the last moment found they could not get away from their official duties and wired me their regrets. The great majority of the mayors, however, as a result of the personal invitation to them, arranged for representation of their city at this convention by one of more technical men connected with their respective municipalities.

The conference discussed many things that come immediately under the supervision of the chief executive and we came to the conclusion that it would be well to bring about a permanent organization reviving, as it were, the old League of American Municipalities, which went out of existence shortly before the war. At the time that former President Wilson called a conference of mayors and chief executives of the states to confer in Washington, it was suggested to revive the old League and an annual convention of Mayors, but for some reason, no one took the initiative to bring this about.

However, those assembled at this conference came to the conclusion that it would be wise, instead of a separate and independent organization meeting at a different time, in as much as the propositions considered by your convention embrace those problems with which municipal executives must deal, to link an annual mayor's conference with the A. S. M. I., and to have your organization appoint a committee to meet with a committee that I have been authorized to appoint, on behalf of the mayors, to work out such a plan, so that some part of the proceedings of the convention of the A. S. M. I. may be set aside where these problems that immediately concern the executives can be considered in a conference of Mayors open to all the representatives to the convention, with preference in the discussion to municipal executives. And so a committee consisting of Mayor Hutchinson and Mr. McGentry, the direct representative of the Mayor of Brookline, Mass., together with myself are here this morning to make this report to you and recommend to this Convention that the President appoint a committee to meet with a committee to be appointed by me, this joint committee to work out some such plan between this and the meeting of the next convention and that they be authorized to extend an invitation to the mayors of American municipalities to meet in Cleveland and there bring about a permanent organization, the whole purpose being to extend the usefulness of this convention and to make more efficient the deliberations and the purpose for which it has been so successfully maintained for these 27 years.

May I also, Mr. President, in view of my having the floor, this report being ended—I would, of course, be glad to have you adopt it—but I want to take advantage to say good-bye to all of you. This probably is the last time that I might have the privilege of saying a word to you. I sincerely hope that you have enjoyed your stay in the city and that your deliberations here in this Convention have been helpful, not only with information, but with an inspiration that will help you in the service that you are rendering to your respective communities. And as you meet year after year, if you should have any trouble in finding a proper place in which to hold your Convention, remember that Baltimore is wide open to you. We will always be glad to welcome you and to extend any courtesy within our power.

MR. HATTON: This is a word for his Honor, Mayor Broening. I have attended a great many of these conventions thruout the country, and I want to say that the ordinary Mayor's address to these Conventions has not been prolific of very much information, inspiration and help. It is just the ordinary speech that the mayors, as mayors, usually make to all conventions. But as I sat here the other morning and listened to Mayor Broening talk to this scientific society, I was inspired with everything he said. He gave us food for thought in every line of work in which we are interested, and I want to say to the Mayor that he made the most inspiring and best and most helpful address of any Mayor whom I have heard speak before this Society, and we all thank him for it. We have heard his speech commended broadly among all the members of this society. I want also to say personally that this Entertainment Committee helped by your President and your Honorable Major Whitman has given this Society a better, more hospitable time than any convention I have ever attended.

On motion the president was authorized to appoint a committee of three to cooperate with the proposed organization of the Conference of Mayors.

The following resolutions were presented by Acting Secretary Folwell on behalf of the Committee on Resolutions.

WHEREAS, The overwhelming burden of taxation has vastly increased the cost of living and is crippling the industries of the United States;

AND WHEREAS, Of the taxes levied, an amount variously estimated at from 75 to 92 per cent is used in paying for past wars and in preparation for future wars, thus diverting enormous sums from the arts of peace and from much needed Federal, State and Municipal improvements;

AND WHEREAS, Huge standing armies and the competitive building of warships have proved to be an incentive to war rather than an insurance against war;

AND WHEREAS, Delegates from the leading nations of the world are now assembling in Washington to discuss the limitation of armaments;

THEREFORE BE IT RESOLVED, That this Society heartily endorses the purpose for which this conference was called and urge upon the delegates from the United States the vital need of using their utmost endeavor to bring it to a successful culmination.

AND BE IT FURTHER RESOLVED, That the Secretary be directed to forward to President Harding a copy of this resolution.

Motion to adopt these resolutions was made, seconded and carried.

RESOLVED: That to the people of Baltimore, all and singular, who have participated in the entertainment of the American Society for Municipal Improvements, its Associates and Guests, there be extended the grateful thanks of the Organization.

The General Convention Committee under the leadership of Major Whitman ably seconded by Mr. Requardt, is to be congratulated upon the success of its efforts to conduct one of the most successful conventions in the Society's History, and to it and its chairmen of sub-committees are extended gratitude and appreciation; also to the Engineer's Club for its several courtesies, to the numerous civic organizations of the City; to the Press Club for the splendid entertainment of Thursday Evening; to the Automobile Club for furnishing, through its members, the vehicles in which the delegates are to make an inspection of the City's parks and other features of interest; to the Street Railway for its courtesies; to the Mayor and his Official Family; to the Southern Hotel, and to the Press, which has made such kindly and intelligent mention of the doings of the Convention.

Motion to adopt these resolutions was made, seconded and carried.

A third set of resolutions adopted will be found on page 447.

A vote of thanks to President Compton for his tactful administration of his office was adopted by a rising vote.

President Compton then turned the Convention over to the incoming President, E. S. Rankin, who accepted the responsibilities of the office in a few words.

The Convention adjourned sine die at 12:30 p. m.

ATTENDANCE AT BALTIMORE CONVENTION

Ac.—Active Member; Af.—Affiliated; As.—Associate; G.—Guest

Adams, Henry, G., Baltimore, Md.
Adler, Julius, Ac., Philadelphia, Pa.
Agnew, P. G., G., New York City.
Ahrens, H. F., As., Leonia, N. J.
Ainslie, Geo., G., Richmond, Va.
Aldridge, W., Ac., Winnipeg, Can.
Allen, C. K., G., Baltimore, Md.
Allen, C. W., G., Baltimore, Md.
Allen, H. C., Ac., Syracuse, N. Y.
Allen, Mrs. H. C., G., Syracuse, N. Y.
Allner, F. A., G., Baltimore, Md.
Anderson, A. M., As., Chicago, Ill.
Anderson, E. A., Af., Cleveland, O.
Anderton, B. A., G., Washington, D. C.
Andress, Geo. W., Ac., Newark, N. J.
Anstine, C. R., G., York, Pa.
Archibald, Alex, G., Newark, N. J.
Armstrong, J. W., Ac., Baltimore, Md.
Armstrong, Mrs. J. W., G., Baltimore, Md.
Aspinwall, J. W., G., New York City.
Atwood, Joshua, Ac., Boston, Mass.
Atwood, Mrs. J., G., Boston, Mass.

Babcock, C. E. P., Ac., Buffalo, N. Y.
Baker, R. E., G., Jacksonville, Fla.
Ballard, W. T., G., Baltimore, Md.
Barnes, H. E., Ac., Shreveport, La.
Barnes, Mrs. H. E., G., Shreveport, La.
Barrett, R. R., As., New York City.
Bascom, H. F., Ac., Allentown, Pa.
Baum, G. H., G., York, Pa.
Bastis, A. G., Ac., Minneapolis, Minn.
Baylis, J. R., Ac., Baltimore, Md.
Beck, Wm. H., G., Baltimore, Md.
Benham, C. J., G., Wallingford, Conn.
Bennett, B. A., Ac., Lynchburg, Va.
Besselievre, E. B., G., New York City.
Besselievre, Mrs. E. B., G., Jersey City, N. J.
Biedler, W. T., G., Baltimore, Md.
Biser, D. B., G., Baltimore, Md.
Blair, W. P., As., Cleveland, O.
Blanchard, A. H., Ac., Ann Arbor, Mich.
Bloch, E., G., Detroit, Mich.
Bowen, J. W., G., Baltimore, Md.
Boyd, C. O., Ac., Beckley, W. Va.
Boyd, Mrs. C. O., G., Beckley, W. Va.
Boyd, J. C., G., Baltimore, Md.
Boyd, Mrs. J. C., G., Baltimore, Md.
Boyles, F. M., G., Baltimore, Md.
Brainard, A. S., G., Newark, N. J.
Braman, Percy, G., Milwaukee, Wis.
Bray, J. T., G., Baltimore, Md.
Broening, Wm. F., G., Baltimore, Md.
Broening, Mrs. W. F., G., Baltimore, Md.
Brown, C. C., Ac., St. Petersburg, Fla.
Brown, Leo, G., Baltimore, Md.
Brown, N. A., Ac., Rochester, N. Y.
Brown, R. E., G., Chicago, Ill.
Brown, T. M., G., Baltimore, Md.
Bryan, G. L., G., Baltimore, Md.
Bryan, Mrs. G. L., G., Baltimore, Md.
Bryant, Mrs. H., G., Baltimore, Md.
Buehler, Walter, Ac., New York City.
Buehler, Mrs. W., G., New York City.
Burleigh, L. J., As., Baltimore, Md.
Buttenheim, E. J., As., New York City.
Buttenheim, Mrs. E. J., G., New York City.
Butterfield, E. E., Ac., New York City.
Butterfield, Mrs. E. E., G., New York City.
Butts, E. A., G., Pittsburg, Pa.
Buxman, Wm., G., New York City.
Buzby, J. S., Ac., Burlington, N. J.

Caller, F. E., G., New York City.
Caller, R. E., G., Philadelphia, Pa.
Campbell, F. C., Ac., Chicago, Ill.
Carlson, Samuel, G., Jamestown, N. Y.
Carr, F. B., G., Baltimore, Md.
Carter, H. L. R., G., Westport, Md.
Carter, Mrs. H. L. R., G., Westport, Md.
Christhilf, A. E., Ac., Baltimore, Md.
Christhilf, Mrs. A. E., G., Baltimore, Md.
Clark, E. S., Ac., Kalamazoo, Mich.
Clark, Mrs. E. S., G., Kalamazoo, Mich.
Clark, J. B., G., Ellicott City, Md.
Clark, Mrs. J. B., G., Ellicott City, Md.
Clark, R. N., G., Hartford, Conn.
Claussen, Oscar, Ac., St. Paul, Minn.
Clews, H. T., As., New York City.
Coats, W. G., As., New York City.
Cobb, George, G., Baltimore, Md.
Collier, H. L., Ac., Atlanta, Ga.
Collins, T. E., Ac., Elizabeth, N. J.
Collins, Mrs. T. E., G., Elizabeth, N. J.

Compton, R. K., Ac., Baltimore, Md.
Compton, Mrs. R. K., G., Baltimore, Md.
Conant, E. R., Ac., Mansfield, Mass.
Conant, Mrs. E. R., G., Mansfield, Mass.
Cooksey, R. M., G., Baltimore, Md.
Cornell, Douglas, Ac., Buffalo, N. Y.
Corson, S. C., Ac., Norristown, Pa.
Costello, J. W., Ac., Newark, N. J.
Coulling, J. O. B., G., Baltimore, Md.
Cox, Miss M. A., G., Baltimore, Md.
Crandell, J. S., G., New York City.
Craver, H. H., Ac., Pittsburg, Pa.
Crozier, B. L., G., Baltimore, Md.
Currie, W. A., Ac., Minneapolis, Minn.
Currie, Mrs. W. A., G., Minneapolis, Minn.
Curry, G. M., G., Philadelphia, Pa.
Cutter, F. G., As., Chicago, Ill.
Cutter, Mrs. F. G., G., Chicago, Ill.
Cutter, Miss Eileen, G., Chicago, Ill.

Dalton, E. L., Ac., Dallas, Tex.
Davis, D. B., Ac., Richmond, Ind.
Davis, E. F., G., Baltimore, Md.
Davis, F. A., G., Baltimore, Md.
Debel, N. H., G., Baltimore, Md.
Day, W. F., G., Lynchburg, Va.
Dibert, H. M., G., Troy, N. Y.
Diven, J. M., G., New York City.
Dodge, G., G., New York City.
Doetsch, Jr., M. A., G., Baltimore, Md.
Donegan, O. A., G., Baltimore, Md.
Doremus, Goline, Ac., Newark, N. J.
Dow, A. W., Ac., New York.
Draney, J. R., As., Ridgewood, N. J.
Draney, Mrs. J. R., G., Ridgewood, N. J.
Draper, Albert, G., Baltimore, Md.
Duff, E. E., Ac., Pittsburg, Pa.
Dunn, F. B., As., Conneaut, O.
Dunn, Mrs. F. B., G., Conneaut, O.
Dutton, E. R., Ac., Minneapolis, Minn.

Eger, Miss Catherine, G., Towson, Md.
Eisert, W. L., G., Baltimore, Md.
Elder, R. M., As., Chicago, Ill.
Eldridge, T. B., G., Raleigh, N. C.
Emmart, W. W., Ac., Baltimore, Md.
Emory, E. B., G., Wilmington, Del.
Emory, W. H., G., Baltimore, Md.
English, J. E., G., Trenton, N. J.
English, Wm. J., G., Baltimore, Md.
Entwisle, E. B., G., Johnstown, Pa.
Evans, M. S., Ac., Pittsburg, Pa.
Evans, S. K., G., Baltimore, Md.

Fairbank, H. S., G., Washington, D. C.
Fairtrace, G. D., Ac., Dallas, Tex.
Field, W. C., G., Decatur, Ill.
Figgins, P. F., G., Baltimore, Md.
Fike, M. F., G., Columbus, O.
Finck, G. E., Ac., Baltimore, Md.
Fisher, E. A., Ac., Lakewood, O.
Fisher, E. A., Ac., Rochester, N. Y.
Fisk, G. F., Ac., Buffalo, N. Y.
Fisk, Mrs. G. F., G., Buffalo, N. Y.
Flanigan, E. L., Aff., Baltimore, Md.
Flanigan, Patrick, G., Baltimore, Md.
Fleagle, A. C., G., Baltimore, Md.
Fletcher, H. E., Ac., W. Chelmsford, Mass.
Fletcher, Mrs. H. E., G., W. Chelmsford, Mass.
Follin, J. W., Af., Philadelphia, Pa.
Folwell, A. P., Ac., New York City.
Forsyth, R. W., G., Baltimore, Md.
Foster, C. M., G., Washington, D. C.
Franklin, Henry, G., Baltimore, Md.
French, S. H., G., Pittsburg, Pa.
French, Mrs. S. H., G., Pittsburg, Pa.
Froehling, H. C., G., Richmond, Va.
Fruen, A. B., G., Minneapolis, Minn.
Fruen, Mrs. A. B., G., Minneapolis, Minn.

Gage, R. L., G., Williamsport, Pa.
Galligan, W. J., Ac., Chicago, Ill.
Garnett, R. D., G., Cincinnati, O.
Gartland, J. J., As., New York City.
Garvin, E. C., Ac., St. Petersburg, Fla.
Gay, Louis W., As., Buffalo, N. Y.
George, Howard, Af., Montclair, N.J.
Gibbs, B. B., G., Pittsburg, Pa.
Gibson, A. M., G., Baltimore, Md.
Giddings, Frederick, Ac., Charlotte, N. C.
Gillum, H. J., As., Chicago, Ill.
Gillum, Mrs. H. J., G., Chicago, Ill.
Godwin, W. S., G., Ampere, N. J.
Goertz, W. H., G., Baltimore, Md.
Goob, C. F., Ac., Baltimore, Md.
Goslau, Justus, Ac., Newark, N. J.
Gray, Cecil, G., Baltimore, Md.
Gray, E. R. Ac., Hamilton, Ont., Canada.
Greene, G. E., G., Baltimore, Md.
Greenough, M. B., As., Cleveland, O.
Gregory, J. H., Ac., Baltimore, Md.
Gregory, Mrs. J. H., G., Baltimore, Md.
Grier, R. H., Ac., Wilmington, Del.
Griffin, J. E., G., Philadelphia, Pa.
Griffith, Lawrence, Ac., Yonkers, N. Y.
Griffith, Mrs. L., G., Yonkers, N. Y.
Grinnalds, J. C., Ac., Baltimore, Md.
Gschwind, Carl E., G., Chicago, Ill.
Gundlach, H. R., G., Baltimore, Md.

Haas, C. A., G., Buffalo, N. Y.
Haas, Mrs. C. A., G., Buffalo, N. Y.
Hackney, J. W., Ac., Atlantic City, N. J.
Hackney, Mrs. J. W., G., Atlantic City, N. J.
Hall, J. W., As., Baltimore, Md.
Hanna, W. S., Ac., Baltimore, Md.
Hanna, Mrs. W. S., G., Baltimore, Md.
Harig, C. G., G., Baltimore, Md.
Harpman, W. C., G., New York City.
Harris, G. K., G., Williamsport, Pa.
Harris, H. F., Ac., Trenton, N. J.
Harris, Mrs. H. F., G., Trenton, N. J.
Hart, Mrs. M. B., G., Buffalo, N. Y.
Hatton, T. C., Ac., Milwaukee, Wis.
Hauglick, John, G., Baltimore, Md.
Haysman, W. C., G., New York City.
Hazzard, Miss, G., Kalamazoo, Mich.
Hebden, E. K., Af., Baltimore, Md.
Hechmer, C. A., G., Hyattsville, Md.
Hecht, A. H., G., Baltimore, Md.
Hedian, J. M., G., Baltimore, Md.
Heilmann, Geo., G., Baltimore, Md.
Helm, J. S., As., New Orleans, La.
Hempelmann, W. L., As., Chicago, Ill.
Hickey, G. M., G., New York City.
Hicks, P. T., G., Decatur, Ill.
Hildreth, H. V., Ac., Boston, Mass.
Hill, Nicholas S., Ac., New York City.
Hittell, John B., Ac., Chicago, Ill.
Hoagland, A. M., G., Williamsport, Pa.
Hogan, F. A., As., Toronto, Canada.
Hogan, J. H., G., Baltimore, Md.
Hogan, M. H., G., Toronto, Ont. Can.
Holbein, E. A., G., Baltimore, Md.
Holbrook, I. S., G., New York City.
Hoover, C. B., Ac., Columbus, O.
Hoover, Mrs. C. B., G., Columbus, O.
Horn, N. E., G., Baltimore, Md.
Horner, W. W., Ac., St. Louis, Mo.
Houck, B. C., G., Williamsport, Pa.
Hoverter, G. A., G., Harrisburg, Pa.
Howard, J. W., Ac., New York City.
Howell, C. L., Ac., Buffalo, N. Y.
Howell, W. A., Ac., Newark, N. J.
Hubbard, P., Ac., New York City.
Hubbard, Mrs. P., G., New York City.
Hugentugler, E. S., G., York, Pa.
Huggins, G. A., G., New York City.
Hundertmark, J. L., G., Baltimore, Md.
Hume, S. W., G., New York City.
Hurst, Francis J., G., Pittsburgh, Pa.
Hussey, R. B., G., Swampscot, Mass.
Hutchins, R. A., G., Portsmouth, Va.
Hutchins, R. T., G., Wheeling, W. Va.

Ireton, J., G., Baltimore, Md.

Jackson, F. H., G., Washington, D. C.
Jandermal, P. A., G., Baltimore, Md.
Jandermal, Mrs. P. A., G., Baltimore, Md.
Jenkins, H. S., Af., Cleveland, O.
Jervey, J. A. P., Ac., Portsmouth, Va.
Johnson, A. L., Ac., Wilmington, Del.
Jones, W. F., Ac., Birmingham, Ala.

Keefer, C. E., G., Baltimore, Md.
Kehler, S. I., Ac., Baltimore, Md.
Kelsey, J. W., G., St. Paul, Minn.
Kendrick, Julian, Ac., Birmingham, Ala.
Kennedy, D. A., As., Boston, Mass.
Kennedy, Sam, G., Baltimore, Md.
Kingsley, E. A., Ac., Little Rock, Ark.
Kinner, Miss B. E., G., Conneaut, O.
Kipp, F. M., G., Baltimore, Md.
Kleeberg, Felix, Ac., New York City.
Klorer, John, Ac., New Orleans, La.
Klunk, J. B., G., Toledo, O.
Knight, A. C., G., Baltimore, Md.
Knisely, S. A., G., Cleveland, O.
Koester, E. F., Ac., Wilmington, Del.
Krieger, A. A., Ac., Louisville, Ky.
Krieger, Mrs. A. A., G., Louisville, Ky.
Kuhns, Charles, G., Baltimore, Md.

Law, L. M., As., New Orleans, La.
Lea, James W., G., Pittsburg, Pa.
Lee, J. L., G., New York City.
Lee, W. E., G., Baltimore, Md.
Leland, W. E., G., Baltimore, Md.
Lenth, G. C. D., As., Chicago, Ill.
Leopold, J. L., As., New York City.
Lewis, D. L., G., Fort Worth, Tex.
Lewis, N. P., Ac., Brooklyn, N. Y.
Lewis, Mrs. N. P., G., Brooklyn, N.Y.
Lindsten, G. T., Ac., Minneapolis, Minn.
Lindville, Donald, G., Baltimore, Md.
Lindville, R. K., Ac., Dansville, Va.
Littell, H. L., G., Philadelphia, Pa.
Little, J. C., Ac., Baltimore, Md.
Little, Mrs. J. C., G., Baltimore, Md.
Loder, T. C., G., Philadelphia, Pa.
Longley, J. E., G., East Orange, N.J.
Louis, J. C., As., Baltimore, Md.
Louis, Mrs. Peter, G., Baltimore, Md.
Lucktenberg, W. H., As., Zanesville, O.
Lucktenberg, Mrs. W. H., G., Zanesville, O.

Macallum, A. F., Ac., Ottawa, Can.
Macatee, W. R., G., Richmond, Va.
MacBean, J. P., G., St. Petersburg, Fla.

MacGregor, R. A., Ac., New York City.
Maier, H. L., Ac., Wilmington, Del.
Marchant, R. R., G., Baltimore, Md.
Marsh, R. P., G., Springfield, Mass.
Mason, L. R., As., Richmond, Va.
Massey, F. F., G., New York City.
Maxwell, A. D., G., New York City.
McArthur, F., Ac., Guelph, Ont.
McArthur, Mrs. F., G., Guelph, Ont.
McCandless, W. W., As., New York City.
McComas, W. E., G., Washington, D. C.
McCormick, P. S., As., Baltimore, Md.
McCormick, Mrs. P. S., G., Baltimore, Md.
McDonald, B. M., G., Chicago, Ill.
McDonald, John H., G., St. Paul, Minn.
McDonough, M. E., G., Philadelphia, Pa.
McEttrich, Edward, G., Brookline, Mass.
McNally, T. J., As., New York City.
Mebus, C. F., Ac., Philadelphia, Pa.
Mebus, Mrs. C. F., G., Glenside, Pa.
Megraw, Wm. A., Ac., Baltimore, Md.
Megraw, Mrs. W. A., G., Baltimore, Md.
Mendelssohn, Isidor, G., Washington, D. C.
Metz, L. V., Ac., Erie, Pa.
Miller, S. F., G., Chicago, Ill.
Millikin, P. J., G., Decatur, Ill.
Monroe, L. W., Ac., Meadville, Pa.
Montgomery, R. G., G., Baltimore, Md.
Mooney, T. G., G,, Ampere, N. J.
Morris, J. E., As., Philadelphia, Pa.
Morse, R. B., G., Baltimore, Md.
Mullen, C. A., Ac., Montreal, Can.
Munday, A. J., G., Chicago, Ill.
Mussina, Lyons, Ac., Williamsport, Pa.
Myers, C. E., G., Philadelphia, Pa.
Myers, E. T. D., G., Richmond, Va.

Near, W. P., Ac., St. Catherines, Can.
Near, Mrs. W. P., G., St. Catherines, Ont.
Neenan, Miss S. G., G., Baltimore, Md.
Newcomb, W. T., G., Easton, Pa.
Newmarsh, W. F., G., Toronto, Ont.
Noel, H. R., G., Baltimore, Md.
Norton, G. H., Ac., Buffalo, N. Y.
Norton, Mrs. G. H., G., Buffalo, N.Y.

O'Connor, J. K., G., Utica, N. Y.
O'Connor, L. W., G., Baltimore, Md.
Otterson, G. W., G., Springfield, O.

Page, Miss Mary, G., Baltimore, Md.
Painter, P. C., Ac., Greensboro, N.C.
Parlin, R. W., Af., New York City.
Parran, J. L., G., Baltimore, Md.
Passano, E. B., G., Baltimore, Md.
Patterson, C. A., G., Torrington, Conn.
Patzig, M. L., Ac., Des Moines, Ia.
Patzig, Mrs. M. L., G., Des Moines, Ia.
Pearse, Langdon, Ac., Chicago, Ill.
Pebworth, Richard, As., Everett, Mass.
Pebworth, Mrs. R. A., G., Norfolk, Va.
Peck, L. F., Ac., Hartford, Conn.
Pederson, L. C., G., Philadelphia, Pa.
Pennybacker, J. E., As., New York City.
Perkins, W. C., As., Philadelphia, Pa.
Perkins, Miss, G., Philadelphia, Pa.
Perring, H. G., Ac., Baltimore, Md.
Perring, Mrs. H. G., G., Baltimore, Md.
Pfeffer, H. M., G., Baltimore, Md.
Pfeffer, H. R., G., Baltimore, Md.
Phillips, R. L., Ac., Meadville, Pa.
Phillips, Mrs. R. L., G., Meadville, Pa.
Phinney, S. H., G., Trenton, N. J.
Pierson, F. W., Ac., Wilmington, Del.
Pilcher, W. B., G., Washington, D. C.
Pimm, E. W., G., Boston, Mass.
Pollock, C. D., Ac., New York City.
Poole, C. A., Ac., Rochester, N. Y.
Potter, Alex, Ac., New York City.
Potter, Mrs. A., G., New York City.
Powell, Sheppard T., Af., Baltimore, Md.
Powell, Mrs. S. T., G., Baltimore, Md.
Pratt, Arthur, G., New York City.
Primrose, Mrs. D. L., G., Elkridge, Md.
Proctor, R. F., Af., Baltimore, Md.
Purcell, Stewart, G., Baltimore, Md.
Pyle, M. A., G., Baltimore, Md.
Pyle, Q. B., G., W. Chelmsford, Mass.
Pyle, Mrs. Q. B., G., W. Chelmsford, Mass.

Rainsbury, J. H., As., Newark, N. J.
Rankin, E. S., Ac., Newark, N. J.
Read, F. C., As., Baton Rouge, La.
Reed, Alex, As., Newark, N. J.
Reed, T. H., As., Jacksonville, Fla.
Reed, T. M., Ac., Pittsburg, Pa.
Reimer, F. A., Ac., E. Orange, N. J.
Reinicker, L. T., G., Baltimore, Md.
Reis, S. A., G., Wilmington, Del.
Rendell, W. H., Ac., Minneapolis, Minn.

Rendell, Mrs. W. H., G., Minneapolis, Minn.
Requardt, G. A., Ac., Baltimore, Md.
Reynolds, T. H., G., York, Pa.
Rhoads, A. S., G., Washington, D. C.
Rice, J. L., G., Philadelphia, Pa.
Rice, J. M., Ac., Pittsburg, Pa.
Richardson, J. W., G., Baltimore, Md.
Ricker, G. A., G., Washington, D. C.
Ricker, Mrs. G. A., G., Washington, D. C.
Ridgway, Robert, Ac., New York City.
Robinson, G. G., G., Toronto, Ont.
Robertson, G. S., Af., Baltimore, Md.
Robertson, Mrs. G. S., G., Baltimore, Md.
Rogers, C. H., As., Rockport, Mass.
Rosengarten, W. E., As., New York City.
Ross, James, Ac., Trenton, N. J.
Ruark, M. J., G., Baltimore, Md.
Ruch, W. A., Ac., Allentown, Pa.

Sammelman, S., Ac., St. Louis, Mo.
Sanborn, J. C., G., Lawrenceville, Ill.
Sargent, J. D., G., Mt. Airy, N. C.
Saville, A. J., Ac., Richmond, Va.
Schiemer, E. M., G., Detroit, Mich.
Schiemer, Mrs. E. M., G., Detroit, Mich.
Schmeisser, E. G., G., Baltimore, Md.
Schott, A. M., Ac., Sioux City, Ia.
Schrock, Mrs. C. E., G., Chicago, Ill.
Schwartz, Benj., G., Baltimore, Md.
Sharp, Nelson, G., Philadelphia, Pa.
Sharples, P. P., As., New York City.
Shattuck, R. B., G., Springfield, Mass.
Shaw, Walter A., G., Chicago, Ill.
Sheaf, F. W., Ac., Rutherford, N. J.
Shelley, H. T., As., Pittsburg, Pa.
Sherrick, E. D., As., Kansas City, Mo.
Sherron, G. A., G., Philadelphia, Pa.
Shirley, H. G., Ac., Towson, Md.
Shirley, Jos. W., Ac., Baltimore, Md.
Shoecraft, E. C., G., Flint, Mich.
Siems, V. B., Ac., Baltimore, Md.
Simonson, O. G., G., Baltimore, Md.
Simpson, A. J., Ac., Newark, N. J.
Simpson, Mrs. A. J., G., Newark, N. J.
Skinner, J. F., Ac., Rochester, N. Y.
Slocum, C. L., G., New York City.
Smart, G. H., G., Troy, N. Y.
Smith, A. C., As., Wallingford, Conn.
Smith, B. L., G., Baltimore, Md.
Smith, E. B., G., Washington, D. C.
Smith, H. H., Ac., Brooklyn, N. Y.
Smith, I. R., G., Baltimore, Md.
Smith, Layton, G., Baltimore, Md.
Smith, N. L., Ac., Baltimore, Md.
Sparks, F. C., Ac., Wilmington, Del.
Spencer, Herbert, As., New York City.
Sprague, N. S., Ac., Pittsburg, Pa.
Stone, Wm. H., Af., Baltimore, Md.
Stone, Mrs. W. H., G., Baltimore, Md.
Strohmeyer, L. S., G., Baltimore, Md.
Stuart, J. B., G., New York City.
Sucro, W. G., Af., Baltimore, Md.
Sullivan, T. F., Ac., Boston, Mass.
Sweeney, D. J., Ac., Buffalo, N. Y.
Sylvester, E. W., Ac., Harrisburg, Pa.

Tall, O. L., G., Norfolk, Va.
Tate, John E., G., Dover, Del.
Taylor, W. H., Ac., Norfolk, Va.
Taylor, W. E., G., Baltimore, Md.
Teal, H. L., G., Lima, O.
Thompson, J. T., G., Baltimore, Md.
Thompson, Mrs. J. T., G., Baltimore, Md.
Thompson, P. L., As., New York City.
Tillson, G. W., Ac., LaGrange, Ill.
Tobin, J. J., As., Boston, Mass.
Tomlin, R. K., As., New York City.
Tope, John, G., Hamilton, Ont. Can.
Trafford, E. W., G., Richmond, Va.
Travilla, J. C., As., St. Louis, Mo.
Travilla, Mrs. J. C., G., St. Louis, Mo.
Triebner, F. E., G., Cleveland, O.
Truelove, G. R., G., Baltimore, Md.

Ulrich, E. B., Ac., Reading, Pa.
Upham, C. M., G., Raleigh, N. C.

Vallient, Miss Mary C., G., Walbrook, Md.
VanEtta, C. J., Ac., Milwaukee, Wis.
Vandewater, J. A., Ac., Buffalo, N. Y.
VanKloeck, Wm., G., Philadelphia, Pa.
VanTrump, Isaac, Ac., Chicago, Ill.
Varney, H. A., Ac., Brookline, Mass.
Varney, W. W., G., Baltimore, Md.
VonKeller, A. R., G., Newark, N. J.
Von Zuben, F. J., Ac., Ft. Worth, Tex.

Wagner, G. J., Ac., Grand Rapids, Mich.
Wahlquist, John, Ac., Minneapolis, Minn.
Walker, Mrs. Norvell, G., Baltimore, Md.
Wallow, C. F., G., York, Pa.
Warren, C. A., G., Baltimore, Md.
Watson, R. M., Ac., Rutherford, N. J.
Weedon, P. T., G., Washington, D. C.
Weller, W. E., Ac., Binghamton, N. Y.

Wells, H. J., G., Philadelphia, Pa.
Wenzel, H. C., Ac., St. Paul, Minn.
Weston, R. S., Ac., Boston, Mass.
Wertsner, C. S., G., Philadelphia, Pa.
Wertsner, G. S., G., Philadelphia, Pa.
White, Linn, Ac., Chicago, Ill.
Whiteley, S. M., G., Baltimore, Md.
Whitman, E. B., Ac., Baltimore, Md.
Whitman, Mrs. E. B., G., Baltimore, Md.
Whitman, W. L., G., Philadelphia, Pa.
Weighardt, G. F., G., Baltimore, Md.
Willey, Oscar, G., Baltimore, Md.
Wilson, S. C., G., New York City.
Williar, H. D., G., Baltimore, Md.
Winslow, R. L., G., Baltimore, Md.
Winston, C. A., Ac., West Orange, N. J.
Wolfe, H. C., G., Baltimore, Md.
Wood, E. S., G., Baltimore, Md.
Wood, L. A. S., As., South Bend, Ind.
Wood, W. M., G., Decatur, Ill.
Wysor, W. W., Af., Baltimore, Md.
Wysor, Mrs. W. W., G., Baltimore, Md.

Young, A. R., As., Kansas City, Mo.
Youngs, Fred D., G., Baltimore, Md.

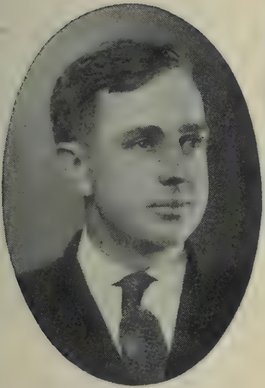
Ziegfield, J. O., G., Baltimore, Md.

Total 524

EXHIBITORS AT THE CONVENTION

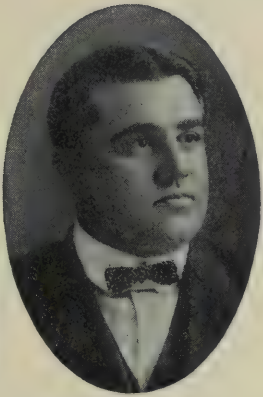
The American City, Tribune Bldg., New York City.
The Asphalt Association, 25 W. 43rd St., New York City.
Austin Western Road Machinery Co., 2220 Market St., Philadelphia, Pa.
The Barrett Co., 40 Rector St., New York City.
Celite Products Co., 11 Broadway, New York City.
Core-Joint Concrete Pipe Co., 1802 Whitmore Ave., Baltimore, Md.
The Dorr Company, 101 Park Ave., New York City.
Dunn Wire-Cut Lug Brick Co., Conneaut, Ohio.
Eastern Paving Brick Mfrs. Assn., Lincoln Bldg., Philadelphia, Pa.
East Iron & Machine Co., Philadelphia, Pa. and Lima, O.
Elgin Sales Co., 501 Fifth Ave., New York City.
Engineering and Contracting, 9 S. Clinton St., Chicago, Ill.
Engineering News-Record, Tenth Ave. at 36th St., New York City.
Fidelity & Deposit Co., Baltimore, Md.
Granite Paving Block Mfrs. Assn., 31 State St., Boston, Mass.
W. & L. E. Gurley, Troy, N. Y.
Hastings Pavement Co., 25 Broad St., New York City.
The Holt Mfg. Co., 50 Church St., New York City.
International Motor Co., Public Works Department, 25 Broadway, New York City.
Koehring Machine Co., Milwaukee, Wis.
Lock Joint Pipe Co., Box 21, Ampere, N. J.
John C. Louis, 221 S. Eutaw St., Baltimore, Md.
Manufacturers Record, Baltimore, Md.
Henry H. Meyer Co., 110 S. Howard St., Baltimore, Md.
Modern City, Baltimore, Md.
National Paving Brick Mfrs. Assn., Cleveland, Ohio.
National Steel Fabric Co., Union Arcade Bldg., Pittsburg, Pa.
Peerless Weighing Machine Co., 1583 Woodward Ave., Detroit, Mich.
The Pioneer Asphalt Co., Lawrenceville, Ill.
Portland Cement Association, 111 W. Washington St., Chicago, Ill.
Public Works, 243 W. 39th St., New York City.
Standard Oil Co. of N. J., Baltimore, Md.
The Texas Co., 17 Battery Place, New York City.
U. S. Asphalt Refining Co., 90 West St., New York City.
Warren Brothers Co., 9 Cambridge St., Boston, Mass.
Wayne Iron Works, Commercial Bldg., Philadelphia, Pa.
The White Co., Cleveland, Ohio.

EDWARD S. RANKIN
President



W. W. HORNER
First Vice-President

ELLIS R. DUTTON
Second Vice-President



HERMAN H. SMITH
Third Vice-President

LINN WHITE
Treasurer

CHARLES C. BROWN
Secretary

OFFICERS OF THE SOCIETY

OFFICERS OF THE SOCIETY FOR THE YEAR 1921-1922

President	EDWARD S. RANKIN	Newark, N. J.
First Vice-President	W. W. HORNER	St. Louis, Mo.
Second Vice-President	ELLIS R. DUTTON	Minneapolis, Minn.
Third Vice-President	HERMAN H. SMITH	New York City
Secretary	CHARLES C. BROWN	St. Petersburg, Fla.
Treasurer	LINN WHITE	Chicago, Ill.

FINANCE COMMITTEE

E. L. DALTON, Chairman	Dallas, Tex.
S. CAMERON CORSON	Norristown, Pa.
JOSHUA ATWOOD	Boston, Mass.

EXECUTIVE COMMITTEE

The officers of the Society, together with the Past Presidents who have retained their continuous membership, constitute the Executive Committee. The names of the Past Presidents are given below.

CONVENTIONS AND PAST PRESIDENTS OF THE SOCIETY

First	1894	Buffalo	M. J. Murphy (deceased), St. Louis
Second	1895	Cincinnati	M. J. Murphy (deceased), St. Louis
Third	1896	Chicago	Geo. H. Benzenberg, Milwaukee
Fourth	1897	Nashville	August Herrmann, Cincinnati
Fifth	1898	Washington	H. Van Duyne (deceased), Newark
Sixth	1899	Toronto	Nelson P. Lewis, New York
Seventh	1900	Milwaukee	A. D. Thompson, Peoria
Eighth	1901	Niagara Falls	Robert E. McMath (deceased), St. Louis
Ninth	1902	Rochester	E. A. Fisher, Rochester
Tenth	1903	Indianapolis	C. H. Rust, Toronto
Eleventh	1904	St. Louis	G. M. Ballard (deceased), Newark
Twelfth	1905	Montreal	A. Prescott Folwell, New York
Thirteenth	1906	Birmingham	Charles C. Brown, Valparaiso
Fourteenth	1907	Detroit	Morris R. Sherrerd, Newark
Fifteenth	1908	Atlantic City	George W. Tillson, LaGrange
Sixteenth	1909	Little Rock	James Owen (deceased), Orlando
Seventeenth	1910	Erie	Julian Kendrick, Birmingham
Eighteenth	1911	Grand Rapids	Fred Giddings, Charlotte
Nineteenth	1912	Dallas	E. A. Kingsley, Little Rock
Twentieth	1913	Wilmington	B. E. Briggs, Erie
Twenty-first	1914	Boston	E. H. Christ, Grand Rapids
Twenty-second	1915	Dayton	William A. Howell, Newark
Twenty-third	1916	Newark	A. F. Macallum, Ottawa
None	1917	Convention omitted on account of the war.	
Twenty-fourth	1918	Buffalo	N. S. Sprague, Pittsburg
Twenty-fifth	1919	New Orleans	E. R. Conant, Manchester
Twenty-sixth	1920	St. Louis	G. H. Norton, Buffalo
Twenty-seventh	1921	Baltimore	R. Keith Compton, Baltimore

STANDING COMMITTEES—1921-1922

GENERAL COMMITTEES

1. STREET PAVING, SIDEWALKS AND STREET DESIGN, STREET MAINTENANCE AND STREET RAILWAY CONSTRUCTION

General Chairman	R. K. COMPTON	Baltimore, Md.
Sub-Chairman "A"	W. A. HOWELL	Newark, N. J.
Sub-Chairman "B"	E. R. CONANT	Mansfield, Mass.
Sub-Chairman "C"	G. H. NORTON	Buffalo, N. Y.
Sub-Chairman "D"	H. MAETZEL	Columbus, O.

Sub-Committee A—Street Paving

W. A. HOWELL, *Chairman*	Newark, N. J.
W. H. TAYLOR, JR.	Norfolk, Va.
A. F. MACALLUM	Ottawa, Ont.

Sub-Committee B—Sidewalks and Street Design

E. R. CONANT, *Chairman*	Manchster, N. H.
G. A. CRAYTON	Pierre, S. D.
S. Q. CANNON	Salt Lake City, Utah

Sub-Committee C—Street Maintenance

GEO. H. NORTON, *Chairman*	Buffalo, N. Y.
WM. H. EAGLE	Columbus, Ohio
E. C. GARVIN	St. Petersburg, Fla.

Sub-Committee D—Street Railway Construction

HENRY MAETZEL, *Chairman*	Columbus, Ohio
G. T. WAGNER	Grand Rapids, Mich.
W. W. WYSOR	Baltimore, Md.

2. CITY PLANNING

General Chairman	NELSON P. LEWIS	Brooklyn, N. Y.
Sub-Chairman "A"	E. A. FISHER	Rochester, N. Y.
Sub-Chairman "B"	HARLAND BARTHOLOMEW	St. Louis, Mo.
Sub-Chairman "C"	LAWRENCE GRIFFITH	Yonkers, N. Y.
Sub-Chairman "D"	JOHN M. RICE	Pittsburg, Pa.

Sub-Committee A—Local Sub-Divisions

E. A. FISHER, *Chairman*	Rochester, N. Y.
THOMAS ADAMS	Ottawa, Can.
HENRY C. ALLEN	Syracuse, N. Y.

Sub-Committee B—Zoning

HARLAND BARTHOLOMEW, *Chairman*	St. Louis, Mo.
J. C. GRINNALDS	Baltimore, Md.
WM. B. FOWLER	Memphis, Tenn.

Sub-Committee C—Utilities

LAWRENCE GRIFFITH, *Chairman*	Yonkers, N.Y.
JAMES A. HOOKE	St. Louis, Mo.
H. G. SHIRLEY	Towson, Md.

Sub-Committee D—Park Systems and Open Spaces

JOHN M. RICE, *Chairman*	Pittsburg, Pa.
A. M. REYNOLDS	Newark, N. J.
ARTHUR LELAND	Newport, R. I.

3. Traffic and Transportation

A. H. BLANCHARD, *Chairman*	Ann Arbor, Mich.
ROBERT HOFFMAN	Cleveland, Ohio
CHARLES O. BOYD	Wilmington, N. C.

4. Street Lighting

CHARLES W. KOINER, *Chairman*	Pasadena, Cal.
EARL A. ANDERSON	Cleveland, Ohio
RALPH TOENSFELDT	St. Louis, Mo.

5. Street Cleaning, Refuse Disposal and Snow Removal

General Chairman	A. P. FOLWELL	New York City
Sub-Chairman "A"	G. D. FAIRTRACE	Dallas, Tex.
Sub-Chairman "B"	J. W. COSTELLO	Newark, N. J.
Sub-Chairman "C"	H. C. WENZEL	St. Paul, Minn.

Sub-Committee A—Street Cleaning

G. D. FAIRTRACE, *Chairman*	Dallas, Tex.
WILLIAM F. SCHWARTZ	Buffalo, N. Y.
GOLINE DOREMUS	Newark, N. J.

Sub-Committee B—Refuse Disposal

J. W. COSTELLO, *Chairman*	Newark, N. J.
W. J. GALLIGAN	Chicago, Ill.
J. D. TRUSS	Birmingham, Ala.

Sub-Committee C—Snow Removal

H. C. WENZEL, *Chairman*	St. Paul, Minn.
C. O. DAVIS	Milwaukee, Wis.
W. P. NEAR	St. Catherines, Ont.

6. Sewerage and Sanitation, Public Comfort Stations

General Chairman	LANGDON PEARSE	Chicago, Ill.
Sub-Chairman "A"	C. M. REPPERT	Pittsburg, Pa.
Sub-Chairman "B"	T. C. HATTON	Milwaukee, Wis.
Sub-Chairman "C"	H. F. BASCOM	Allentown, Pa.

Sub-Committee A—Sewerage

C. M. REPPERT, *Chairman*	Pittsburg, Pa.
H. P. EDDY	Boston, Mass.
J. H. GREGORY	Baltimore, Md.

Sub-Committee B—Sanitation, including Sewage Disposal

T. C. HATTON, *Chairman*	Milwaukee, Wis.
F. A. DALLYN	Toronto, Ont.
C. ARTHUR POOLE	Rochester, N. Y.

Sub-Committee C—Public Comfort Stations

H. F. BASCOM, *Chairman*	Allentown, Pa.
E. E. PARKER	Madison, Wis.
A. E. CHRISTHILF	Baltimore, Md.

7. Water Works and Water Supply

GEORGE W. FULLER, *Chairman*	New York City, N. Y.
G. G. EARL	New Orleans, La.
A. M. BUSWELL	Urbana, Ill.

8. Municipal Legislation and Finance

JAMES E. BARLOW, *Chairman*	New London, Conn.
JAMES W. FOLLIN	Philadelphia, Pa.
F. W. PIERSON	Wilmington, Del.

9. Fire Prevention

ALCIDE CHAUSSÉ, *Chairman*	Montreal, Can.
E. R. DAVIS	Newport News, Va.
DOUGLAS CORNELL	Buffalo, N. Y.

10. Public Markets

L. D. CUTCHEON, *Chairman*	Grand Rapids, Mich.
G. T. LINDSTEN	Minneapolis, Minn.
S. C. HADDEN	Indianapolis, Ind.

11. Convention Papers

C. C. BROWN, *Chairman*	St. Petersburg, Fla.
E. S. RANKIN	Newark, N. J.
GEO. W. TILLSON	LaGrange, Ill.

12. Convention Arrangements

ROBERT HOFFMAN, *Chairman*	Cleveland, O.

Sub-Committee on Papers on Cleveland Features

C. M. OSBORN, *Chairman*	East Cleveland, O.

Sub-Committee on Entertainments

M. B. GREENOUGH, *Chairman*	Cleveland, O.

Sub-Committee on Finances

JAMES H. HERRON	Cleveland, O.

Sub-Committee on Automobiles

SPENCER M. DUTY, *Chairman*	Cleveland, O.

Sub-Committee on Reception and Information

E. A. ANDERSON, *Chairman*	Nela Park, Cleveland, O.

Sub-Committee on Membership

E. A. FISHER, *Chairman*	Lakewood, O.

Sub-Committee on Exhibits

MAURICE B. GREENOUGH, *Chairman*	Cleveland, O.

Sub-Committee on Badges

C. M. Osborn, *Chairman*	East Cleveland, O.

SPECIFICATIONS COMMITTEES

1. Sheet Asphalt Pavements

E. A. KINGSLEY, *Chairman*	Little Rock, Ark.
FRANCIS P. SMITH	New York City
PREVOST HUBBARD	New York City
A. A. KRIEGER	Louisville, Ky.
FELIX KLEEBERG	New York City

2. Bituminous Macadam, Bituminous Concrete and Asphalt Block Pavements

THOMAS E. COLLINS, *Chairman*	Elizabeth, N. J.
A. W. DOW	New York City
JULIUS ADLER	Philadelphia, Pa.
MONROE L. PATZIG	Des Moines, Iowa
ROBERT E. GAGE	Trenton, N. J.

3. Broken Stone and Gravel Roads, With or Without Bituminous Surface Treatment

D. B. DAVIS, *Chairman*	Richmond, Ind.
H. F. HARRIS	Trenton, N. J.
J. B. HAWLEY	Nashville, Tenn.
J. H. MACDONALD	New Haven, Conn.
S. C. CORSON	Norristown, Pa.

4. Brick Pavements

G. F. FISK, *Chairman*	Buffalo, N. Y.
E. B. ULRICH	Reading, Pa.
E. E. DUFF, JR.	Pittsburg, Pa.
E. H. CHRIST	Grand Rapids, Mich.
E. A. FISHER	Lakewood, O.

5. Cement-Concrete Pavements

THOMAS J. WASSER, *Chairman*	Trenton, N. J.
WILLIAM D. UHLER	Harrisburg, Pa.
D. Q. McCOMB	Nashville, Tenn.
A. B. FLETCHER	Sacramento, Cal.
E. L. DALTON	Dallas, Texas

6. Stone Block Pavements

R. A. MACGREGOR, *Chairman*	New York City
JOSHUA ATWOOD	Boston, Mass.
H. A. VARNEY	Brookline, Mass.
W. A. HOWELL	Newark, N. J.
C. D. POLLOCK	New York City

7. Wood Block Pavements

E. R. DUTTON, *Chairman*	Minneapolis, Minn.
M. R. SHERRERD	Newark, N. J.
GEORGE CHAMPE	Toledo, Ohio
JOHN KLORER	New Orleans, La.
GEORGE E. FINCK	Baltimore, Md.

8. Sidewalks and Curbs

SYLVERIUS SAMMELMAN, *Chairman*	St. Louis, Mo.
F. J. CELLARIUS	Dayton, Ohio
H. A. ROWLAND	McPherson, Kan.
R. L. PHILLIPS	Meadville, Pa.
J. W. HACKNEY	Atlantic City, N. J.

9. Sewers

C. L. HOWELL, *Chairman*	Buffalo, N. Y.
ALEXANDER POTTER	New York City
EDGAR S. DORR	Boston, Mass.
GUY BROWN	St. Louis, Mo.
WALTER G. KIRKPATRICK	Baltimore, Md.

10. Sub-Grade and Foundations

FRED A. REIMER, *Chairman*	Newark, N. J.
H. H. CRAVER	Pittsburg, Pa.
JAMES LOGAN	Mt. Holly, N. C.
ROBERT D. KNEALE	Atlanta, Ga.
JOHN B. HITTELL	Chicago, Ill.

11. Street Railway Pavements Including Track Construction

CHARLES E. DELEUW, *Chairman*	Chicago, Ill.
WM. VON PHUL	San Francisco, Cal.
HENRY MAETZEL	Columbus, Ohio
G. T. WAGNER	Grand Rapids, Mich.
FRED C. DUNLAP	Philadelphia, Pa.

SPECIAL COMMITTEES

1. Standard Tests for Bituminous Material

FRANCIS P. SMITH, *Chairman*	New York City
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R. B. GAGE	Trenton, N. J.
LESTER KIRSCHBRAUN	Chicago, Ill.
FELIX KLEEBERG	New York City

2. STANDARD TESTS FOR NON-BITUMINOUS MATERIAL

ARTHUR H. BLANCHARD, *Chairman*	Ann Arbor, Mich.
THOMAS H. BRANNAN	Columbus, Ohio
AUSTIN B. FLETCHER	Sacramento, Cal.
CLARENCE D. POLLOCK	New York City
WALLACE L. CALDWELL	Louisville, Ky.

3. PUBLICITY

CHARLES C. BROWN, *Chairman*	St. Petersburg, Fla.
A. PRESCOTT FOLWELL	New York City
MAURICE B. GREENOUGH	Cleveland, O.

4. MEMBERSHIP

W. W. HORNER, *Chairman*	St. Louis, Mo.
E. R. CONANT	Manchester, N. H.
G. A. PARKER	Hartford, Conn.
HERMAN H. SMITH	New York City
THOMAS E. COLLINS	Elizabeth, N. J.
EDMUND B. ULRICH	Reading, Pa.
G. J. REQUARDT	Baltimore, Md.
J. A. P. JERVEY	Portsmouth, Va.
CHARLES O. BOYD	Wilmington, N. C.
CHARLES C. BROWN	St. Petersburg, Fla.
E. A. FISHER	Lakewood, O.
E. H. CHRIST	Grand Rapids, Mich.
D. B. DAVIS	Richmond, Ind.
LINN WHITE	Chicago, Ill.
ELLIS R. DUTTON	Minneapolis, Minn.
EDGAR A. KINGSLEY	Little Rock, Ark.
E. L. DALTON	Dallas, Tex.
G. A. CRAYTON	Pierre, S. D.
SYLVESTER Q. CANNON	Salt Lake City, Utah
GEORGE H. FREITAS	Modesto, Calif.
A. F. MACALLUM	Ottawa, Ont.
GEORGE W. CRAIG	Calgary, Alberta
J. C. TRAVILLA	St. Louis, Mo.

REPRESENTATIVES IN OTHER ORGANIZATIONS

AMERICAN SOCIETY FOR TESTING MATERIALS

Committee D-4 on Road Materials

HERMAN H. SMITH, *Delegate*	Brooklyn, N. Y.
LINN WHITE, *Alternate*	Chicago, Ill.

Committee C-4 on Clay and Cement Sewer Pipe

W. W. HORNER, *Delegate*	St. Louis, Mo.
ALEXANDER POTTER, *Alternate*	New York City

NATIONAL RESEARCH COUNCIL

Division of Engineering

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E. R. DUTTON, *Delegate*	Minneapolis, Minn.
CHARLES O. BOYD, *Alternate*	Wilmington, N. C.

PAVING BRICK COMMITTEE OF U. S. DEPARTMENT OF COMMERCE

GEORGE F. FISK, *Delegate*	Buffalo, N. Y.
D. B. DAVIS, *Alternate*	Richmond, Ind.

COMMITTEE ON STANDARDS FOR DRINKING WATER, DIVISION OF SIMPLIFIED PRACTICE, U. S. DEPARTMENT OF COMMERCE

MORRIS R. SHERRERD, *Delegate*	Newark, N. J.
J. W. ARMSTRONG, *Alternate*	Baltimore, Md.

AMERICAN ENGINEERING STANDARDS COMMITTEE

Committee on Standard Tests for Penetration for Bituminous Materials

A. W. DOW, *Delegate*	New York City
PREVOST HUBBARD, *Alternate*	New York City

MEMBERSHIP LIST

ACTIVE

Ackerman, J. Walter, City Manager, Watertown, N. Y.	1905
Adler, Julius, Deputy Chief, Bureau of Highways, Pniladelphia, Pa.	1921
Aldrich, Bruce, Manager Provincial Contracting Company, Ltd., Toronto, Ont., Can.	1919
Aldridge, William, Assistant City Engineer, 333 McGee St., Winnipeg, Manitoba, Can.	1912
Allen, Henry C., Consulting Engineer, Syracuse, N. Y.	1895
Allen, Kenneth, Sanitary Engineer, Board of Estimate and Apportionment, 1235 Municipal Building, New York City	1920
Allin, Thomas D., Allin Brothers, Civil Engineers, 303 Kendall Building, Pasadena, Cal.	1905
Andress, George W., Senior Engineer Division of Works, 445 Summer Avenue, Newark, N. J.	1921
Anthony, Harvey Mitchell, Consulting Electrical Engineer, Member Indiana State Board for Registering and Examining of Professional Engineers and Land Surveyors, Anthony Building, Muncie, Ind.	1921
Armstrong, J. W., Filtration Engineer, Water Department, Lake Montebello, Hillen Road, Baltimore, Md.	1921
Ash, Louis R., Harrington, Howard & Ash, Consulting Engineers, Kansas City, Mo.	1911
Askwith, F. C., Deputy City Engineer, 203 Powell Ave., Ottawa, Ont. Can.	1916
Atwood, Joshua, Engineer in Charge Paving Service, 501 City Hall Annex, Boston, Mass.	1914
Babcock, C. E. P., First Assistant Engineer, 20 Municipal Building, Buffalo, N. Y.	1914
Baechlin, Ernest, Town Engineer, National Bank Building, Bloomfield, N. J.	1916
Baillarge, W. D. City Engineer, Quebec, Que. Can.	1912
Bair, Maurice Z., Chief Engineer, State Board of Health, Little Rock, Ark.	1920
Baldry, William Earnest, City Engineer, 1106 W. Thirteenth St., Topeka, Kan.	1918
Ball, Edwin, Member of Board of Chosen Freeholders, Newark, N. J.	1921
Ballenger, John E., General Manager, D. G. Aronberg & Co., Wallace Block, New Castle, Pa.	1913
Barbour, Frank A., Consulting Engineer, 1120 Tremont Building, Boston, Mass.	1914
Barlow, James E., City Manager, City Hall, New London, Conn.	1910
Barnes, H. E., City Engineer, City Hall, Shreveport, La.	1920
Barnett, Howard H., City Engineer, City Hall, Pontiac, Mich.	1919
Bartholomew, Harland, Engineer City Plan Commission, 231 Municipal Courts Building, St. Louis, Mo.	1914
Bartley, John C., Secretary to Superintendent Sewerage and Water Board, 402 Sewerage and Water Board Building, New Orleans, La.	1920
Bartow, Edward, Head of Department of Chemistry, State University of Iowa, Iowa City, Iowa	1920
Bascom, H. F., City Engineer, City Hall, Allentown, Pa.	1920
Bastis, Albert G., Chairman Committee on Paving, 2629 S. 6th St., Minneapolis, Minn.	1917
Bates, William F., Town Engineer, Municipal Building, Montclair, N. J.	1922
Batson, S. R., City Engineer of Bessemer, 411 N. 30th Street, Birmingham, Ala.	1920
Battershill, J. D., Municipal Engineer, Box 15, East Kildonan, Manitoba, Can.	1920

Baylis, J. R., Principal Sanitary Chemist, City Water Department, Montebello Filters, Hillen Road, Baltimore, Md	1911
Belt, Edwin K., Assistant City Engineer, 525 Woodward Ave., Kalamazoo, Mich.	1915
Benham, Webster L., Consulting Engineer, 512 Gimbel Building, Kansas City, Mo	1916
Bennett, Boyd A., Director Public Works, Lynchburg, Va	1921
Benzenberg, George H., Consulting Engineer, 1018 Wells Building, Milwaukee, Wis	1894
Berthe, L. T., City Engineer, President Berthe Engineering Company, Charleston, Mo	1917
Black, Wilbert, Commissioner of Public Property, City Hall, New Orleans, La	1922
Blanchard, Arthur H., Professor of Highway Engineering and Highway Transport, Engineering Building, University of Michigan, Ann Arbor, Mich	1909
Bohannon, John N., County and Project Engineer, Sandersville, Ga.	1919
Bowden, Lewis G., Member of Board of Chosen Freeholders, Cedar Grove, N. J	1919
Boyd, Charles O., Wilmington, N. C	1920
Bragstad, R. E., Assistant City Engineer, Sioux Falls, S. D.,	1922
Brannan, Thomas H., Engineer the Franklin Asphalt Paving Company, 209 S. High St., Columbus, Ohio	1913
Breed, H. Eltinge, Consulting Engineer, Room 600, 507 Fifth Ave., New York City	1921
Brennan, W. C., W. C. Brennan Contracting Company, Hamilton, Ont., Can	1909
Brewer, W. H., City Engineer, City Hall, Terre Haute, Ind	1922
Briggs, B. E., Consulting Engineer, 207 Marine Bank Building, Erie, Pa	1902
Brockway, P. L., City Engineer, Wichita, Kansas	1918
Brown, Charles Carroll, Consulting Engineer, City Engineer, P. O. Box 234, St. Petersburg, Fla	1895
Brown, Guy, Principal Assistant Engineer, Sewer Design, St. Louis, Mo	1920
Brown, N. Adelbert, Engineer Sewage Disposal, 152 Post Ave., Rochester, N. Y	1921
Brown, Thurber A., City Engineer, 416 E. Church St., Elmira, N. Y.	1908
Bull, Irving C., Bull & Roberts, 50 West St., New York City	1912
Burden, W. W., Engineer, Department of Sewers and Paving, St. Louis, Mo	1920
Burnside, Lewis E., City Engineer, City Building, Sharon, Pa	1922
Buswell, A. M., Chief, State Water Survey Division, Urbana, Ill	1920
Butterfield, Elmore E., in Charge of Laboratory, Boro of Queens, 68 Hunters Point Ave., Long Island City, N. Y	1921
Buzby, J. Stewart, Conard & Buzby, Consultants & Engineers, 322 High St., Burlington, N. J	1920
Caldwell, Wallace L., Assistant to President, Kentucky Rock Asphalt Company, Marion E. Taylor Building, Louisville, Ky	1913
Cannon, Sylvester Q., City Engineer, Salt Lake City, Utah	1915
Carpenter, George A., City Engineer, Pawtucket, R. I.	1905
Carroll, James E., Assistant Chief Engineer and Superintendent of Construction and Repairs, Department of Public Works, 1682 Lincoln Ave., St. Paul, Minn	1921
Carson, H. O., City Engineer, Central Fire Station, W. North Street, Butler, Pa	1917
Carter, Hugh R., 803 A. O. U. W. Bldg., Little Rock, Ark	1909
Cellarius, Frederick J., Consulting Engineer, 1001 Commercial Bldg., Dayton, Ohio	1910
Champe, George, Civil Engineer, 610 Nasby Bldg., Toledo, Ohio	1920
Chase, Alden, Engineer of Construction, Sewers and Paving Division, St. Louis, Mo	1920

Chaussé, Alcide, Hon. Secretary Royal Architectural Institute of Canada, P. O. Box 304, Montreal, Que., Can	1901
Christ, Edward H., Civil and Consulting Engineer, Norris Building, Grand Rapids, Mich	1908
Christhilf, A. E., Highway Engineer, City Hall, Baltimore, Md	1912
Clark, Edward S., City Engineer, Kalamazoo, Mich	1921
Claussen, Oscar, Chief Engineer, Department of Public Works, City Hall, St. Paul, Minn	1921
Codwise, Edward B., City Engineer, 298 Wall St., Kingston, N. Y	1906
Coile, C. E., Engineer for Green Co., Pike Commission and City Engineer, Greenville, Tenn	1916
Collier, Henry L., City Engineer, City Hall, Atlanta, Ga	1908
Collins, Clarke P., Manager Clarksburg Engineering Company, Inc., 801-2 Goff Building, Clarksburg, W. Va	1909
Collins, Thomas E., City Engineer, City Hall, Elizabeth, N. J	1916
Compton, R. Keith, Chairman and Consulting Engineer, Paving Commission, 214 E. Lexington St., Baltimore, Md	1915
Conant, Elbridge R., Surveyor, City Hall, Manchester, N. H	1913
Cook, J. C., Chief Engineer the J. B. McCrary Co., 1408 Third National Bank Building, Atlanta, Ga	1913
Cooper, C. M., City Engineer, Columbus, Kansas	1913
Cornell, Douglas, Structural Engineer and First Assistant to Commissioner of Buildings, 6 Municipal Building, Buffalo, N. Y	1915
Corning, Dudley T., 1908 Biltmore St., Washington, D. C	1909
Corson, S. Cameron, Boro Engineer, City Hall, Norristown, Pa	1908
Costello, James W., Chief Engineer, Division of Works, City Hall, Newark, N. J	1919
Cowden, M. B., City Engineer, Harrisburg, Pa	1916
Craig, George W., City Engineer, City Hall, Calgary, Alberta, Can	1911
Crane, Z. G., Member of Board of Chosen Freeholders, West Caldwell, N. J	1921
Craver, H. H., Manager Chemical Department, Pittsburg Testing Laboratory, 616 Grant St., Pittsburg, Pa	1914
Crayton, G. A., Highway Designer, State Highway Commission, Pierre, S. D	1912
Crecelius, W. E., Assistant Engineer, Bridges and Buildings, St. Louis, Mo	1920
Crosby, Walter W., Consulting Engineer, 307 E. 30th St., Baltimore, Md	1909
Culverhouse, Harry G., Assistant State Engineer, Bell Building, Montgomery, Ala	1919
Cunliff, Nelson, Secretary Housing Association, Chamber of Commerce, Res. 5819 Cates Ave., St. Louis, Mo	1919
Curfman, Lawrence E., City Engineer, 406 W. Adams Ave., Pittsburg, Kan	1910
Currie, C. H., Consulting Engineer, Webster City, Iowa	1917
Currie, W. A., Alderman, 4th Ward, Minneapolis, Minn	1921
Curtis, Thomas H., Civil Engineer, Fairmont, Minn	1921
Cutcheon, L. D., Secretary and General Manager, Board of Public Works, Grand Rapids, Mich	1906
Cutter, A. B., City Engineer, Everett, Wash	1917
Dallyn, Frederick A., Provincial Sanitary Engineer, Province of Ontario, Parliament Buildings, Toronto, Ont. Can	1916
Dalton, E. L., 9-10 Murphy Building, Dallas, Tex	1906
Daly, C. M., Engineer, Water Department, St. Louis, Mo	1920
Darcey, Henry J., State Sanitary Engineer, State Laboratory, 401 East 2d St., Oklahoma City, Okla	1921
Davenport, James H., Member of Board of Chosen Freeholders, 101 Linden Ave., Irvington, N. J	1919
Davis, D. B., City Engineer, Richmond, Ind	1918
Davis, E. Russell, Chief Civil Engineer, Court House, Newport News, Va	1919

Decker, A. Clinton, Mayor, Fairfield, Ala	1920
DeLay, Theodore S., Consulting Engineer, Creston, Iowa	1910
DeLeuw, Charles E., Kelker, Gates & DeLeuw, 1206 Conway Building, Chicago, Ill	1920
Dingle, James H., City Engineer, City Hall, Charleston, S. C.	1908
Doremus, Goline, Assistant Engineer, Department of Streets and Public Improvements, 53 Heller Parkway, Newark, N. J	1920
Dorr, Edgar S., Engineer in Charge of Special Work, Sewer Service, 707 City Hall Annex, Res. 213 Savin-Hill Ave., Boston 25, Mass.	1914
Doughty, Joshua, Jr., Town and County Engineer, Somerville, N. J.	1918
Douthitt, M. J., City Engineer, City Hall, Waukegan, Ill	1911
Dow, A. W., Consulting Engineer, Dow and Smith, 131 E. Twenty-third St., New York City	1899
Drake, Edward Consulting Engineer, Ocala, Fla	1922
Drake, W. O., City Engineer and Superintendent Department of Public Works, City Hall, Corning, N. Y	1921
Drinkwater, Ernest, City Engineer, 588 Desaulniers Blvd., St. Lambert, Que	1918
Drowne, Henry B., 40 Converse St., Long Meadow, Mass	1912
Duck, Allen Douglas, Consulting Engineer, Box 218, Greenville, Tex.	1913
Duff, Edward E., Jr., District Engineer, Eastern Paving Brick Mfrs. Asso., 3402 Schaffer Place, South Hills Sta., Pittsburg, Pa	1916
Dunlap, Fred C., Chief of Bureau of Highways, City Hall, Philadelphia, Pa	1915
Durham, Henry Welles, Consulting Engineer, c/o Knowlton Durham, 2 Rector Street, New York City	1913
Dutton, E. R., Assistant City Engineer, 3240 Dupont Ave., Minneapolis, Minn	1914
Eager, George, Supervisor of Roads, Essex County, Millburn, N. J.	1916
Eagle, W. H., Superintendent of Municipal Asphalt Plant, City Hall, Columbus, Ohio	1919
Earl, George G., General Superintendent, Sewerage and Water Board, New Orleans, La	1906
Earle, Roscoe K., City Engineer, 606 E. 8th St., Davenport, Iowa	1920
Eckley, S. W., Commissioner of Public Works, 1305 S. Adams St., Peoria, Ill	1919
Eddy, Harrison P., Metcalf & Eddy, Consulting Civil Engineers, 14 Beacon St., Boston, Mass	1914
Eichelberger, F. O., City Manager, Dayton, O	1915
Elliott, John L., City Civil Engineer, City Hall, Indianapolis, Ind	1922
Ellsworth, Frank VP., Southwestern Engineering Company, Texarkana, Ark	1908
Emerson, C. A., Jr., Chief Engineer, State Department of Health, Harrisburg, Pa	1917
Emerson, Guy C., Consulting Engineer, Boston Finance Commission, 73 Tremont St., Boston, Mass	1922
Emerson, Lewis A., Secretary-Treasurer Tomlinson Engineering Company, 1002 Loan and Exchange Building, Columbia, S. C.	1920
Emmart, Wm. M., Consulting City Planner, 1101 Union Trust Building, Baltimore, Md	1921
Evans, M. S., Director of Tests, Department of Public Works, Center and Dethridge Sts., Pittsburg, Pa	1918
Evinger, Morris I., Station A., Lincoln, Neb	1918
Fairtrace, George D., City Engineer, Dallas, Tex	1919
Ferebee, James L., Principal Assistant Engineer, Sewerage Commission, City Hall, Milwaukee, Wis	1921
Filby, E. L., State Sanitary Engineer, State Board of Health, Columbia, S. C.	1921
Finch, B. K., City Engineer, Wilkes-Barre, Pa	1908
Finck, George E., Highways Engineer, 120 Schenck St., Greensboro, N. C.	1921

Fisher, E. A., City Engineer, City Hall, Lakewood, Ohio	1917
Fisher, E. A., Consulting Engineer and Superintendent of City Planning, Rochester, N. Y.	1897
Fisk, George F., Assistant Engineer in Charge of Pavement Construction, Bureau of Engineering, Department of Public Works, 20 Municipal Building, Buffalo, N. Y.	1916
Fitzgerald, John Daniel, Honorable the Minister for Local Government, Education Building, Loftus St., Sydney, N. S. W., Australia	1920
Fletcher, Austin B., Director State Department Public Works, Forum Building, Sacramento, Cal.	1912
Fletcher, Herbert E., Consulting Engineer, West Chelmsford, Mass.	1921
Flood, Walter H., 22 Quincy St., Chicago, Ill.	1918
Folwell, A. Prescott, Municipal Engineering Consultant, Park Row Building, New York City	1901
Fowler, William B., City Engineer, Memphis, Tenn.	1917
Fox, Robert L., Engineer, 37 E. Broad St., Bethlehem, Pa.	1920
Francisco, Ellsworth, Engineer in Charge of Bureau of Public Lighting, 204 City Hall, Newark, N. J.	1922
Freire, Victor de Silva, City Chief Engineer, P. O. Box 18, Sao Paulo, Brazil	1922
Freitas, George H., City Engineer, Modesto, Cal.	1913
Friedrich, Frank X., Commissioner of Streets and Public Improvements, Joliet, Ill.	1921
Frommer, Charles, Acting Chief of Bureau of Surveys, Philadelphia, Pa.	1921
Fuess, W. W., Secretary Northern Road Improvement District, Stuttgart, Ark.	1919
Fugate, Harry C., City Engineer, West Palm Beach, Fla.	1916
Fuller, George W., Consulting Engineer, 170 Broadway, New York City	1906
Gage, Robert B., Chemical Engineer State Highway Commission, Taylor Place, Trenton, N. J.	1920
Gainey, W. H., City Engineer, Valdosta, Ga.	1906
Galligan, William J., Assistant Superintendent of Streets in charge of Street and Alley Cleaning, 408 City Hall, Chicago, Ill.	1922
Gans, R. C., Engineer, Department of Streets and Sewers, St. Louis, Mo.	1920
Garges, S. J., Commissioner of Public Works, City Hall, New Rochelle, N. Y.	1919
Garvin, Edgerton Chester, Director of Public Works, City Hall, St. Petersburg, Fla.	1919
Gaymon, D. P., City Engineer, Pueblo, Colo.	1920
Gaynor, Keyes C., 525-7 Trimble Building, Sioux City, Iowa	1911
Giddings, Fred, Consulting Engineer, 906 East Boulevard, Charlotte, N. C.	1896
Giles, John A., Hoadley and Giles, Civil Engineers, 415 Phelps Bank Building, Binghamton, N. Y.	1911
Gillen, Charles P., Mayor, Newark, N. J.	1914
Gillette, Halbert P., Consulting Appraisement Engineer, Editor Engineering and Contracting, 9 S. Clinton St., Chicago, Ill.	1919
Goob, Charles F., Chief Engineer Electrical Commission, 2810 Maryland Ave., Baltimore, Md.	1921
Goslau, Justus, Chemist to Newark Department of Public Improvements, Cedar Grove, N. J.	1919
Gottschalk, L. F., Special Engineer for City and County, Columbus, Neb.	1918
Graham, Frank P., Boro and County Engineer, Grove City, Pa.	1922
Gray, E. R., City Engineer, Hamilton, Ont., Can.	1916
Greeley, Samuel A., Pearse, Greeley and Hanson, Consulting Engineers, 39 W. Adams St., Chicago, Ill.	1919
Green, Howard R., Consulting Engineer, 634-5 Cedar Rapids Savings Bank Building, Cedar Rapids, Iowa	1919

Gregory, John H., Consulting Engineer, Professor of Civil and Sanitary Engineering, The Johns Hopkins University, Homewood, Baltimore, Md.	1921
Grier, R. Henry, Director, Street and Sewer Department, 1610 Franklin St., Wilmington, Del.	1919
Griffin, John A., City Engineer, 405 S. City Hall Annex, Los Angeles, Cal.	1920
Griffith, Lawrence A., City Engineer, City Hall, Yonkers, N. Y.	1920
Griggs, Charles E., City Engineer, 212 E. Jasper St., Tulsa, Okla.	1919
Grinnalds, Jefferson C., Assistant Engineer, City Plan Commission, Baltimore, Md.	1921
Grover, Charles M., Member of Board of Chosen Freeholders, 606 Summer Ave., Newark, N. J.	1916
Hackney, John W., City Engineer, 141 St. Charles Place, Atlantic City, N. J.	1908
Hadert, John A., New Rochelle, N. Y.	1918
Hall, John W., City Engineer and Water Superintendent, Choteau, Mont.	1919
Hall, William H., City Engineer, New Britain, Conn.	1917
Hamley, S. J., District Manager Pittsburg Testing Laboratory, 520 National Bank Building, Cleveland, Ohio	1917
Hammersley, W. P., Town Manager, 18 Marion Ave., Norwood, Mass.	1919
Hammond, George T., Consulting Engineer, 156 Berkeley Place, Brooklyn, N. Y.	1908
Hanna, Wesley S., Deputy City Comptroller, City Hall, Baltimore, Md.	1921
Hansell, Jr., William A., 1504 Healey Building, Atlanta, Ga.	1916
Hansen, Paul, Pearse, Greeley & Hansen, Hydraulic and Sanitary Engineers, 39 W. Adams St., Chicago, Ill.	1913
Harper, E. F., City Engineer, East St. Louis, Ill.	1920
Harper, Leon L., Consulting Engineer, City Hall, Quincy, Ill.	1922
Harris, Harry F., Mercer County Engineer, Trenton, N. J.	1910
Harris, R. C., Commissioner of Works, Toronto, Ont., Can.	1914
Hatton, T. Chalkley, Chief Engineer of Sewerage Commission, City Hall, Milwaukee, Wis.	1903
Hawkins, A. J., City Engineer, City Hall, Birmingham, Ala.	1922
Hawley, John B., Consulting Engineer, 255 Burton Building, Ft. Worth, Tex.	1912
Hawley, John B., Highway Engineer, U. S. Bureau of Public Roads, 327 Seventh Ave., N., Nashville, Tenn.	1917
Heebink, G. E., City Engineer, Goodwin Block, Beloit, Wis.	1917
Heimbuecher, W. A., City Engineer, University City, Mo.	1920
Helland, Hans, City Engineer, 1109 McCullough Ave., San Antonio, Tex.	1917
Helland, H. R. F. City Engineer and Water Superintendent, City Hall, Waxahachie, Tex.	1920
Hellen, C. J., Assistant Chief Examiner, City Service Commission, 306 Court House, Baltimore, Md.	1922
Hering, Rudolph, Consulting Engineer, 40 Lloyd Road, Montclair, N. J.	1910
Herrmann, August, Wiggins Block, Cincinnati, Ohio	1894
Hicks, Lawrence M., Member of Board of Chosen Freeholders, 34 Clinton St., Newark, N. J.	1919
Highland, Scotland G., General Manager Water Works, Clarksburg, W. Va.	1921
Hill, C. D., Engineer, Board of Local Improvements, 207 City Hall, Res., 1730 W. 104th St., Chicago, Ill.	1920
Hill, Nicholas S., Jr., Hill and Ferguson, Consulting Engineers, 112 E. 19th St., New York City	1911
Hills, George B., George B. Hills Co., Consulting Engineers, 36 Barnett Building, Jacksonville, Fla.	1913
Hines, Henry C., Member of Board of Chosen Freeholders, 810 Broad St., Newark, N. J.	1921

Hittell, John B., District Engineer, the Asphalt Association, 29 S. LaSalle St., Chicago, Ill	1908
Hoffman, Robert, Chief Engineer, Department of Public Service, Cleveland, Ohio	1908
Hooke, James A., Director Public Utilities, St. Louis, Mo	1920
Hoopes, Edgar M., Jr., P. O. Box 895, Wilmington, Del	1915
Hoover, Clarence B., Superintendent, Division of Water and Sewerage, City Hall, Columbus, Ohio	1917
Horner, W. W., Chief Engineer, Sewers and Paving, 300 City Hall, St. Louis, Mo	1915
Howard, J. W., Consulting Paving Engineer and Testing Laboratory, 234 Mt. Prospect Ave., Newark, N. J	1901
Howe, S. B., City Engineer, 220 S. Grange Ave., Sioux Falls, S. D	1920
Howe, William E., County Engineer, Erie, Kans	1918
Howell, Carl L., 7 Municipal Building, Buffalo, N. Y	1914
Howell, Robert B., Gen. Mgr., Metropolitan Water District, Omaha, Neb	1920
Howell, William A., Engineer in charge, Bureau of Paving, City Hall, Newark, N. J	1907
Hubbard, Prevost, Chemical Engineer the Asphalt Association, 25 W. 43d St., New York City	1913
Hudson, Leo, Consulting Hydraulic and Sanitary Engineer, Box 14, Boston, Allegheny Co., Pa	1911
Hughes, Charles W., Civil Engineer, 2147 Fifth St., Port Arthur, Tex	1920
Hughes, Hector James, Dean of the Harvard Engineering School, Harvard University, Cambridge, Mass	1914
Hull, Walter L., City Engineer, City Hall, Orange, N. J	1920
Hunter, Lionel McL., Roadway Engineer, City Engineer's Office, 7 Willard Ave., Ottawa, Ont., Can	1916
Jackson, Frank H., Senior Assistant Testing Engineer, Bureau of Public Roads, Washington, D. C	1922
Jaudon, H. S., Consulting and Supervising Engineer, Box 582, Elberton, Ga	1920
Jeffries, L. D., City Engineer, 302 City Hall, Peoria, Ill	1918
Jewell, Albert H., Chief Engineer, State Board of Health, Lawrence, Kans	1921
Johnson, A. L., Street and Sewer Director, Wilmington, Del	1921
Johnson, George A., George A. Johnson Co., Consulting Engineers, 150 Nassau St., New York City	1917
Jones, Maurice L., City Engineer, and Superintendent of Public Works, 368 Washington St., Benton Harbor, Mich	1920
Jones, Woolsey F., Engineer Birmingham Realty Co., 2118 1st Ave., Birmingham, Ala	1921
Judson, Clayton O., City Engineer, 1811 Faraon St., St. Joseph, Mo	1919
Judson, H. D., St. Joseph, Mo	1918
Judson, William Pierson, Consulting Engineer, President Broadalbin Electric Light and Power Co., Broadalbin, Fulton County, N. Y.	1902
Kastberg, Karl C., Engineer, Box 923, Des Moines, Iowa	1918
Kehler, S. I., Associate Civil Engineer, 202 City Hall, Baltimore, Md.	1921
Kendrick, Julian, Consulting Engineer, 606 First National Bank Building, Birmingham, Ala	1898
Kershaw, G. Bertram, Consulting Engineer, 9 Victoria St., Westminster London, S. W. England	1918
Kiel, H. W., Mayor, St. Louis, Mo	1920
Kingsley, Edgar A., Highway and Municipal Engineer, 321 Exchange Bank Building, Little Rock, Ark	1908
Kinsey, E. R. President, Board of Public Service, St. Louis, Mo	1920
Kirkpatrick, Walter G., Municipal and Hydraulic Engineer, 2103 Erdman Ave., Baltimore, Md	1912
Kirschbraun, Lester, Consulting Engineer, 160 N. Wells St., Chicago, Ill	1909

Kleeberg, Felix, Chemist, Department of Public Works, Municipal Building, New York City	1915
Klorer, John, City Engineer, New Orleans, La	1921
Klyce, B. H., 720 Fourth and First National Bank Building, Nashville, Tenn	1913
Kneale, Robert D., Consulting Engineer, Georgia School of Technology, Atlanta, Ga	1917
Koester, Edwin F., Engineer in Charge of Surveying, 811 West St., Wilmington, Del	1921
Koiner, C. W., City Manager, Pasadena, Cal	1913
Kramer, Xavier A., Consulting Engineer, Magnolia, Miss	1919
Kress, Bancroft, Practicing Municipal Engineer, Box 804, Elkins, W. Va	1920
Krieger, A. A., Chief Engineer, City Hall, Louisville, Ky	1921
Lalonde, J. A., Assistant Supt. of Streets of Montreal, 23 Duverger Ave., Outremont, P. Q., Can	1921
Lawrence, E. A., Jennings-Lawrence Co., 511-12 Hartman Building, Columbus, Ohio	1915
Lee, B. M., City Engineer, Asheville, N. C	1908
Lee, R. B., City Engineer, 105 First St., E., Hutchinson, Kans	1918
Legaré, T. Keith, District Engineer, Dow and Smith, 1327 Main St., Columbia, S. C	1916
Leland, Arthur, Supervisor of Recreation, City Hall, Newport, R. I	1919
Lenderink, Andrew, Consulting Engineer, 501 Kalamazoo National Bank Building, Kalamazoo, Mich	1912
Lewis, E. T., Commissioner of Streets and Sewers, City Hall, Nashville, Tenn	1921
Lewis, Nelson P., 1511 Albemarle Road, Brooklyn, N. Y	1895
Lindeman, Philip, Member of Board of Chosen Freeholders, 53 Osborne Terrace, Newark, N. J	1921
Lindsley, F. O., Member of Board of Chosen Freeholders, 42 Sanford St., East Orange, N. J	1921
Lindsten, Gottfried T., Alderman, City Council, 2122 N. Bryant Ave., Minneapolis, Minn	1921
Lingley, Ralph G., Superintendent of Sewer Department, 31 City Hall, Worcester, Mass	1920
Linville, Ralph K., City Engineer, Danville, Va	1920
Little, John C., The Development & Construction Company, 506 American Building, Baltimore, Md	1910
Logan, James, County Engineer, Mt. Holly, N. J	1918
Lovewell, Maurice N., Assistant Engineer, South Park Commission, Fifty-seventh St. and Cottage Grove Ave., Chicago, Ill	1912
Luster, W. H., Elizabeth, N. J	1905
Macallum, Andrew F., Commissioner of Public Works, Ottawa, Ont., Can	1909
MacDonald, James H., Road and Pavement Expert, Temple and Chapel Sts., New Haven, Conn	1914
MacDonald, Walter Elwood, City Water Works Engineer, 21 Fourth Ave., Ottawa, Ont., Can	1919
MacGregor, R. A., Assistant Engineer, Department of Public Works, Boro of Manhattan, Municipal Building, New York City	1915
Macksey, H. V., Superintendent of Public Works, Framingham, Mass	1921
Maetzel, Henry, Paving Engineer, Street Railway Company, 165 E. Deshler St., Columbus, Ohio	1908
Mahnken, Alfred J., Civil and Constructing Engineer and Contract Manager, 95 River St., Hoboken, N. J	1917
Mahony, J. J., City Clerk, St. Johns, Newfoundland	1921
Maier, Harry L., Engineer in Charge of Sewers, Wilmington, Del	1919
Makino, U., Civil Engineer Bureau of Public Works, Japanese Home Department, Tokio, Japan	1919

Malone, James, City Engineer, Department of Streets and Public Improvements, Sioux City, Iowa	1920
Mangold, John F., Armour Institute of Technology, Chicago, Ill	1913
McArthur, Franklin, City Engineer, Guelph, Ont., Can	1916
McCarthy, P. A., Consulting Engineer and City Engineer, Lufkin, Tex	1917
McClelland, Richard J., City Engineer, Kingston, Ont., Can	1917
McComb, Dana Quick, Chief Engineer, State Highway Department, Nashville, Tenn	1917
McElroy, James A., City Engineer, City Hall, Bridgeport, Conn	1920
McKellip, F. W., City Engineer, Faribault, Minn	1918
McVea, J. C., City Engineer, Houston, Tex	1919
Meade, R. E., P. O. Box 94, Florence, Ala	1906
Mebus, Charles F., Albright and Mebus, Consulting Engineers, 1512 Land Title Building, Philadelphia, Pa	1920
Megraw, Wm. A., President Water Board and Water Engineer, City Hall, Baltimore, Md	1921
Mentz, H. A., Principal Assistant Engineer of X. A. Kramer, Magnolia, Miss	1919
Mercier, Paul E., Consulting Engineer of the Administrative Commission, City Hall, Montreal, Que., Can	1910
Metz, L. V., Civil Engineer, Erie, Pa	1910
Miller, Chalmers C., City Engineer, City Hall, Lorain, Ohio	1919
Miller, H. E., Director Bureau of Sanitary Engineering, State Board of Health, Raleigh, N. C	1921
Miner, Franklin M., Assistant Engineer, Street Laying Out Department, 404 City Hall Annex, Boston, Mass	1913
Mitchell, Lequin, City Manager, Lufkin, Tex	1919
Monroe, Lowell W., Assistant City Engineer, Meadville, Pa	1921
Montgomery, Julian, City Engineer, Wichita Falls, Tex	1920
Morales, Luis, Consulting Engineer, Architect and General Contractor, Aguiar No. 84, Havana, Cuba, Res. F entre 13 y 15-Vedado, Havana, Cuba	1917
Morath, Ben J., Deputy Commissioner of Public Property, 18 City Hall, New Orleans, La	1922
Morse, Robert Brooks, Chief Engineer State Department of Health and of Washington Suburban Sanitary District, 16 W. Saratoga St., Baltimore, Md	1921
Moseley, Hal, Commissioner of Streets and Public Property, Dallas, Tex.	1915
Mullen, Charles A., Consulting Paving Engineer, Director of Paving Department, Milton Hersey Co., Ltd., 84 St. Antoine St., Montreal, Que., Can	1911
Mungle, William, Member of Board of Chosen Freeholders, 640 Ridge St., Newark, N. J	1921
Murray, Charles W., City Engineer, Miami, Fla	1918
Mussina, Lyons, City Engineer, Williamsport, Pa	1921
Myers, William G., City Engineer, Harrisonburg, Va	1916

Naylor, A. W., City Engineer, Navasota, Texas	1921
Near, W. P., City Engineer, St. Catherine, Ont., Can	1915
Nevitt, J. H., Engineer in Charge of Main Sewage Disposal, 348 Lake Front, Toronto, Ont., Can	1920
Newton, S. D., Cleveland, Tenn	1913
Noble, O. E., Municipal Engineer, Norton, Kans	1908
Norton, George H., City Engineer, 20 Municipal Building, Buffalo, N. Y	1914
Nutting, H. C., H. C. Nutting Company, Hunt and Broadway, Cincinnati, Ohio	1919

Oakes, Henry G., City Engineer, Muskegon Heights, Mich	1920
O'Leary, Arthur L., Commissioner of Streets and Public Improvements, East St. Louis, Ill	1920
Olmsted, Frederick L., Landscape Architect, Brookline, Mass	1909

Osgood, Manley, Ann Arbor Asphalt Construction Co., 716 National Bank Building, Ann Arbor, Mich	1914
Osthaus, Leo, Assessor of Special Taxes, St. Louis, Mo	1920
Overland, Arthur B., City Engineer, Austin, Minn	1919
Pace, M. D., City Engineer, Troy, Ala	1920
Paffrath, Ernest, Assistant Engineer, Sewers and Paving, St. Louis, Mo.	1920
Painter, Pennell C., City Manager, Greensboro, N. C	1921
Pape, F. W., Park Commissioner, St. Louis, Mo	1920
Parent, Arthur, Superintendent of City Lighting Department, Montreal, Que., Can	1905
Parker, E. E., City Engineer, Madison, Wis	1917
Parker, G. A., Secretary and Treasurer State Park Commission, Superintendent of Parks, Municipal Building, Hartford, Conn	1902
Patterson, C. A., City Engineer, City Hall, Torrington, Conn	1921
Patzig, Monroe L., Consulting Paving Engineer, 206-10 Eleventh St., Des Moines, Iowa	1918
Pearse, Langdon, Sanitary Engineer, the Sanitary District of Chicago, 910 S. Michigan Ave., Chicago, Ill	1919
Peck, Leon F., Superintendent of Streets, Municipal Building, Hartford, Conn	1913
Pendleton, Henry H., City Engineer, 620 S. Main St., Independence, Mo	1918
Perrine, J. Franklin, Engineer of Sewers, Queens Subway Building, Long Island City, N. Y	1921
Perring, H. G., Chief Engineer, City Hall, Baltimore, Md	1921
Phillips, Roy L., City Engineer, Meadville, Pa	1919
Phul, William von, Member of Ford, Bacon & Davis, President and General Manager United Railroads of San Francisco, 58 Sutter St., San Francisco, Cal	1911
Pierce, Herbert W., Commissioner of Public Works, 26 City Hall, Rochester, N. Y	1914
Pierce, James S., Mayor, Dunkirk, N. Y	1919
Pierson, Frank W., Secretary Board of Directors, Street and Sewer Department, Wilmington, Del	1915
Pitzman, Julius, City Surveyor, St. Louis, Mo	1920
Pollock, Clarence D., Consulting Engineer, Park Row Building, New York City	1902
Poole, C. Arthur, City Engineer, City Hall, Rochester, N. Y	1918
Porter, John L., Director Water Purification Stations, 8407 Panola St., New Orleans, La	1919
Potter, Alexander, Consulting Civil Engineer, 50 Church St., New York City	1913
Pratt, Charles, City Engineer and Superintendent of Water Works, Chanute, Kansas	1918
Proctor, Edward M., James, Proctor and Redfern, Consulting Engineers, 36 Toronto St., Toronto, Ont., Can	1920
Rankin, E. S. Engineer in Charge, Bureau of Sewers, City Hall, Newark, N. J	1903
Ray, Clare M., City Engineer, Kokomo, Ind	1920
Raymond, T. L., Director Department of Streets and Public Improvements, City Hall, Newark, N. J	1919
Reed, Tom M., Assistant Chief Engineer Streets, Playgrounds and Parks, 17 E. Lacock St., Pittsburg, Pa	1918
Reese, C. A., City Engineer, City Hall, Easton, Pa	1922
Reimer, Frederick A., County Engineer Essex County, Court House, Newark, N. J	1909
Rendell, W. H., Paving Committee, City Council, 400 Builders Exchange, Minneapolis, Minn	1921
Reppert, Charles M., Chief Engineer Bureau of Engineering, Department of Public Works, 421 City-County Building, Res. 6324 Bartlett Ave., Pittsburg, Pa	1908

Requardt, G. J., Consulting Engineer, 615 Munsey Building, Baltimore, Md	1921
Reynolds, A. M., Chief Engineer of Essex County Park Commission, 115 Clifton Ave., Newark, N. J	1908
Rice, John M., Engineer, 411 Oliver Building, Pittsburg, Pa	1918
Richards, H. S., Superintendent of Maintenance and Repairs, South Park Commissioners, 6920 Constance Ave., Chicago, Ill.	1909
Ridgway, Robert, Engineer of Subway Construction, Transit Construction Commission, 49 Lafayette St., New York City	1908
Ridley, Clarence E., City Manager, Bluefield, W. Va	1919
Rogers, Niart, City Engineer, Asbury Park, N. J	1909
Rolfe, W. E., Associate to President, Board of Public Service, St. Louis, Mo	1920
Root, Joseph E., Sewerage Engineer, Department of Public Service, Delaware Building, Akron, Ohio	1915
Ross, James A., County Supervisor of Roads, 4 Southard St., Trenton, N. J	1919
Routh, James W., Consulting Engineer, 1856 Fairmount Ave., St. Paul, Minn	1916
Rowland, H. A., City Engineer, McPherson, Kans	1917
Ruch, William A., Commissioner of Highways, City Hall, Allentown, Pa	1920
Rudolph, Charles A., 900 Van Buren St., Wilmington, Del	1912
Rust, Charles H., Toronto Electric Light Co., 12 Adelaide St., E., Toronto, Ont., Can	1898
Sammelman, Sylverius, Engineer, Chamber of Commerce, 511 Locust St., St. Louis, Mo	1915
Sargent, George H., City Engineer, LaGrange, Ga	1918
Sarver, William Edward, City Engineer, Canton, Ohio	1915
Saville, A. J., Director of Public Works, City Hall, Richmond, Va	1921
Sawyer, Walter H., Sawyer and Bean, Hydraulic Engineers, 11 Lisbon St., Lewiston, Maine	1918
Scacciaferro, S. John, Engineer with Alexander Potter, 506 Highland Ave., Clifton, N. J	1921
Schmoll, John, Director of Public Welfare, St. Louis, Mo	1920
Schott, A. M., Engineer, Sioux Falls, Iowa	1920
Schutt, Harold G., Assistant City Manager, Bluefield, W. Va	1921
Schwartz, William F., Street Commissioner, 64 Franklin St., Buffalo, N. Y	1919
Schweizer, Jr., Rudolph, Village Engineer, 20 Edwin St., Ridgfield Park, N. J	1920
Seward, Jr., Oscar A., City Engineer and Chief Engineer of Wharf and Dock Commission, Beaumont, Tex	1921
Shaner, H. L., Commissioner of Public Works, City Hall, Winston-Salem, N. C	1908
Shaw, Walter A., Consulting Engineer, 30 N. LaSalle St., Chicago, Ill	1922
Sheaf, Fred W., Mayor, Rutherford, N. J	1917
Shelton, William H., City Engineer, 617 Central Ave., Dunkirk, N. Y.	1916
Shepard, Frank T., Town Engineer of Belleville, 352 Center St., Nutley, N. J	1920
Shepheard, Fred H., Assistant Engineer, Boro Hall, Long Island City, N. Y	1922
Sherrerd, Morris R., Chief Engineer, Department of Streets and Public Improvements, City Hall, Newark, N. J	1896
Shirley, Henry G., Roads and Sanitary Engineer, Baltimore County, Towson, Md	1921
Shirley, Joseph W., Chief Engineer Topographical Survey Commission, Baltimore, Md	1921
Siems, V. Bernard, Associate Civil Engineer, Water Department, Baltimore, Md	1921
Simons, Jr., George W., Chief Sanitary Engineer, State Board of Health, Jacksonville, Fla	1922

Simpson, Arthur J., Engineer Bureau of Docks, Department of Streets and Public Improvements, City Hall, Newark, N. J.	1920
Skidmore, Hugh W., President Chicago Paving Laboratory Inc., 160 N. Wells St., Chicago, Ill.	1921
Skinner, John F., Assistant City Engineer, Rochester, N. Y.	1921
Slater, J. M., Street Commissioner, St. Louis, Mo.	1920
Smith, Benjamin LeCompte, Member Norton, Bird and Whitman, Engineers, 615 Munsey Building, Baltimore, Md.	1922
Smith, Francis P., Consulting Engineer, Dow and Smith, 131-133 E. Twenty-third St., New York City	1908
Smith, Herman H., Deputy Chief Engineer, Division of Public Improvements, 1347 Municipal Building, New York City	1915
Smith, J. J., Engineer, Widlund Block, Grand Forks, N. D.	1913
Smith, Nathan L., Associate Civil Engineer of Highways, Paving Commission, 4110 Belle Ave., Baltimore, Md.	1921
Smythe, Edward, Superintendent of Garbage Collection, 410 Persimmon St., Peoria, Ill.	1918
Snyder, Frederick Antes, Res. Engineer N. Y.-N. J. Vehicular Tunnel, 105 Carnegie Ave., East Orange, N. J.	1914
Sobolewski, E. F., Principal Assistant Engineer Paving Design, St. Louis, Mo.	1920
Southgate, W. W., City Engineer, City Hall, Nashville, Tenn.	1920
Sprague, Norman S., Engineer, 808-10 Wabash Building, Pittsburg, Pa.	1908
Starks, W. Fred, County Superintendent of Highways, Glen Cove, N. Y.	1917
Steed, Robert E., City Clerk, P. O. Box 919, Norfolk, Va.	1911
Stevenson, John D., Engineer Division of Bridges, 1231 Monterey St., N. S., Pittsburg, Pa.	1912
Stevenson, W. L., Assistant Chief Engineer, State Department of Health, Harrisburg, Pa.	1918
Stiffelman, Joseph, Engineer of Maintenance, Street Department, St. Louis, Mo.	1920
Stoecker, William, Engineer of Maplewood and Webster Groves, St. Louis, Mo.	1920
Storrie, William, Consulting Civil Engineer, 625 Confederation Life Building, Toronto, Ont., Can.	1920
Sucro, Wm. D., Chief Engineer, Commission for Opening Streets, Baltimore, Md.	1921
Sullivan, Thomas F., Chairman of Board of Transit Commissioners, 1 Beacon St., Boston 9, Mass.	1919
Swan, John, Director Department of Public Works, City-County Building, Pittsburg, Pa.	1919
Sweeney, Daniel J., City Clerk, City Hall, Buffalo, N. Y.	1920
Sylvester, Elbert W., Portland Cement Association, Finance Building, Philadelphia, Pa.	1913
Talbot, A. N., Professor of Municipal and Sanitary Engineering, University of Illinois, Urbana, Ill.	1896
Taplin, Arthur E., Consulting Engineer, Box 423, High Point, N. C.	1917
Taylor, Jr., W. H., Director of Public Works, 61 Stockley Gardens, Norfolk, Va.	1917
Thomas, E. J., City Engineer, Minot, N. D.	1919
Thompson, Geo. W., General Manager, Westmount, Que., Canada	1921
Thum, William, 123 Columbia St., Pasadena, Cal.	1912
Tillson, George W., Consulting Engineer, 313 S. Catherine Ave., LeGrange, Ill.	1897
Toensfeldt, Ralph, Engineer Division of Lighting, St. Louis, Mo.	1920
Tolles, Frank C., Superintendent Bureau of Public Works, Department of Public Service, Delaware Building, Akron, O.	1922
Tomlinson, W. S., City Engineer, Columbia, S. C.	1921
Tremblay, Thomas, City Engineer, 30 Peel St., Sherbrooke, Quebec	1919

Tribus, Louis L., Tribus and Massa, Consulting Engineers, 15 Park Row, New York City	1908
Truss, J. D., Commissioner of Public Improvements, 7827 Underwood Ave., Birmingham, Ala	1917
Turner, J. W., Consulting Highway Engineer, Lakeland, Fla	1917
Tuska, Gustave R., Consulting Engineer, 68 William St., New York City	1915
Uhler, William D., Chief Engineer, State Highway Department, Harrisburg, Pa	1914
Ulrich, Edmund B., City Engineer, Reading, Pa	1914
Vandewater, J. A., 7 Municipal Building, Buffalo, N. Y	1914
Van Duyne, Harrison R., Deputy Chief Engineer, City Hall, Newark, N. J	1920
Van Etta, C. J., Superintendent of Street Construction and Repair, Department of Public Works, 705 39th St., Milwaukee, Wis	1919
Van Trump, Isaac, Consulting Asphalt Engineer, 2337 S. Paulina St., Chicago, Ill	1911
Varney, Henry A., Town Engineer, 25 Town Hall, Brookline, Mass	1916
Vars, Alexander, City Engineer, 814 Webster Place, Plainfield, N. J	1916
Vaughn, W. A., Civil and Testing Engineer, 143 W. Main St., Evansville, Wis	1921
Veatch, Jr., N. T., Black and Veatch, Consulting Engineers, Mutual Building, Kansas City, Mo	1920
Von Zuben, Frank J., Baker and Von Zuben, Municipal Engineers and Surveyors, Ft. Worth, Texas	1912
Waddell, Robert W., City Engineer, City Hall, Kansas City, Mo	1918
Wagner, Gerald J., Director of Public Service, 539 Jefferson Ave., S. E., Grand Rapids, Mich	1919
Wagner, Joseph C., Assistant Director of Public Works, Philadelphia, Pa	1921
Wahlquist, John, Alderman, 2528 Elliot Ave., Minneapolis, Minn	1921
Wakenhut, Paul G., Salina, Kans	1920
Wall, Edward E., Water Commissioner, St. Louis, Mo	1920
Walters, R. Earle, Boro Engineer, Municipal Building, Tarentum, Pa	1920
Warden, Herman, Chairman of Library Board, Pasco, Wash	1920
Wasser, Thomas J., State Highway Engineer, Trenton, N. J	1913
Watson, Robert M., Boro Engineer, Rutherford, N. J	1908
Weaver, H. J., City Engineer, Elkhart, Ind	1918
Weber, B. B., City Engineer, City Building, Oil City, Pa	1917
Webster, Edwin R., Consulting Engineer, 412 Webster Building, 327 S. LaSalle St., Chicago, Ill	1916
Weller, W. Earl, City Engineer, 26 Crary Ave., Binghamton, N. Y	1916
Wells, John J., Civil and Consulting Engineer, Rocky Mount, N. C	1921
Wentworth, Russell A., Civil Engineer, Expert on Valuations, Curtis Block, Batavia, N. Y	1918
Wenzel, Herman C., Commissioner of Public Works, 301 Court House, St. Paul, Minn	1920
Weston, Robert Spurr, Weston and Sampson, Consulting Engineers, 14 Beacon St., Boston, Mass	1914
White, Jr., Charles E., Commissioner of Public Works, Municipal Building, Oak Park, Ill	1920
White, Linn, Chief Engineer, South Park Commissioners, 57th St. and Cottage Grove Ave., Chicago, Ill	1908
Whitman, Ezra B., Public Service Commissioner of Maryland, Baltimore, Md	1921
Willey, Marney B., Nagle, Witt, Rollins Engineering Co., 4030 Junius St., Dallas, Tex	1919
Williams, E. D., Sewers and Paving Division, St. Louis, Mo	1920
Willigerod, W. D., City Engineer, City Hall, East Orange, N. J	1913

Wingfield, Nisbet, Consulting Engineer, 812-5 Lamar Building, Augusta, Ga.	1906
Winn, Jr., Thomas E., Engineer in Charge of Paving Construction, Alexander Apartments, W. 4th St., Winston-Salem, N. C.	1919
Winston, Charles A., Engineer, West Orange, N. J.	1920
Wise, B. A., City Engineer, Bradford, Pa.	1916
Wise, Colin R., City Engineer, 301 Gregory Ave., Passaic, N. J.	1915
Wise, Russell S., Wise and Watson, Consulting Engineers, 34 Bloomfield Ave., Passaic, N. J.	1921
Wise, W. H., City Engineer and Commissioner of Public Works, Augusta, Ga.	1922
Withrow, Edgar P., Engineer in Charge of Municipal Testing Laboratory, 55 Municipal Courts Building, St. Louis, Mo.	1918
Woermann, John W., Room 1201, 537 S. Dearborn St., Chicago, Ill.	1920
Wolfinger, Wellington R., Assistant Construction Engineer, State Highway Department, 1548 Powell St., Norristown, Pa.	1918
Wolman, Abel, Division Engineer' State Department of Health, Editor Journal of American Water Works Association, 16 W. Saratoga St., Baltimore, Md.	1921
Woodward, Arthur H., Deputy Superintendent of Streets, City Hall, Springfield, Mass.	1919
Wynne-Roberts, R. O., Consulting Engineer, 40 Jarvis St., Toronto, Ont.	1918

MUNICIPAL MEMBERS AND THEIR DELEGATES

ALLENTOWN, PA.
- H. F. Bascom
- W. A. Ruch

AUGUSTA, GA.
- W. H. Wise

BALTIMORE, MD.
- A. E. Christhilf

BEAUMONT, TEX.
- O. A. Seward, Jr.

BINGHAMTON, N. Y.
- W. Earl Weller

BUFFALO, N. Y.
- C. E. P. Babcock
- Douglas Cornell
- G. F. Fisk
- C. L. Howell
- G. H. Norton
- W. F. Schwartz
- J. A. Vandewater

CHANUTE, KAN.
- Charles Pratt

DANVILLE, VA.
- R. K. Linville

ELIZABETH, N. J.
- Thomas E. Collins

ELKHART, IND.
- H. J. Weaver

ESSEX COUNTY, N. J.
- Edwin Ball
- Lewis G. Bowden
- Z. G. Crane
- James H. Davenport
- George Eager
- Charles M. Grover
- Lawrence M. Hicks
- Henry C. Hines
- Philip Lindeman
- F. O. Lindsley
- William Mungle
- F. A. Reimer

EVERETT, WASH.
- A. B. Cutter

FARIBAULT, MINN.
- F. W. McKellip

GUELPH, ONT.
- Franklin McArthur

HARRISBURG, PA.
- M. B. Cowden

HOUSTON, TEX.
- J. C. McVea

ILLINOIS STATE WATER SURVEY DIVISION
- A. M. Buswell

JOLIET, ILL.
- Frank X. Friedrich

KANSAS CITY, MO.
- Robert W. Waddell

KANSAS STATE BOARD OF HEALTH
- A. H. Jewell

LOS ANGELES, CAL.
- John A. Griffin

LOUISVILLE, KY.
- A. A. Krieger

LUFKIN, TEX.
- Lequin Mitchell

MEMPHIS, TENN.
W. B. Fowler

MINNEAPOLIS, MINN.
Albert Bastis
W. A. Currie
Ellis R. Dutton
G. T. Lindsten
W. H. Rendell
John Wahlquist

MONTREAL, CAN.
Paul E. Mercier
Arthur Parent

NEWARK, N. J.
James W. Costello
Goline Doremus
Ellsworth Francisco
Charles P. Gillen
Justus Goslau
William A. Howell
Edward S. Rankin
T. L. Raymond
M. R. Sherrerd

NEW ORLEANS, LA.
Wilbert Black
John Klorer
Ben J. Morath

NEW ROCHELLE, N. Y.
S. J. Garges

NEW SOUTH WALES, AUSTRALIA
J. D. Fitzgerald

NORFOLK, VA.
R. E. Steed
W. H. Taylor, Jr.

NORRISTOWN, PA.
S. Camerson Corson

NORWOOD, MASS.
W. P. Hammersley

OMAHA, NEB.
Robert B. Howell

ONTARIO, Province of,
F. A. Dallyn

PASADENA, CAL.
C. W. Koiner

PASCO, WASH.
Herman Warden

PAWTUCKET, R. I.
George A. Carpenter

PEORIA, ILL.
S. W. Eckley
L. D. Jeffries
Edward Smythe

PHILADELPHIA, PA.
Julius Adler
Fred C. Dunlap
Charles Frommer
Joseph C. Wagner

PONTIAC, MICH.
Howard H. Barnett

QUEBEC, CAN.
W. D. Bailliarge

READING, PA.
Edmund B. Ulrich

ROCHESTER, N. Y.
Herbert W. Pierce

RUTHERFORD, N. J.
F. W. Sheaf

ST. JOHNS, NEWFOUNDLAND
J. J. Mahoney

ST. LOUIS, MO.
Guy Brown
W. W. Horner
E. R. Kinsey
W. E. Rolfe
S. Sammelman
J. C. Travilla

ST. PETERSBURG, FLA.
E. C. Garvin

SALT LAKE CITY, UTAH
Sylvester Q. Cannon

SANDERSVILLE, GA.
John N. Bohannon

SIOUX CITY, IOWA
James Malone

TORONTO, ONT.
R. C. Harris

WESTMOUNT, QUE.
G. W. Thompson

WILKES-BARRE, PA.
B. K. Finch

WILMINGTON, DEL.
R. H. Grier
A. L. Johnson
E. F. Koester
H. L. Maier
F. W. Pierson
F. C. Sparks

WINSTON-SALEM, N. C.
H. L. Shaner

WORCESTER, MASS.
Ralph G. Lingley

AFFILIATED MEMBERS

Anderson, Earl A., Illuminating Engineer, National Lamp Works, Nela Park, East Cleveland, Ohio	1920
Ballinger, Walter F., Ballinger and Perrot, Architects and Engineers, 17th and Arch Sts., Philadelphia, Pa	1918
Bassett, W. A., National Institute of Public Administration, 261 Broadway, New York City	1918
Campbell, John, Superintendent Special Service Department, Edison Electric Illuminating Co., 39 Boylston St., Boston, Mass	1913
Cross, Roy, Kansas City Testing Laboratory, 1013 Grand Ave., Kansas City, Mo	1918
Diel, Charles H., Secretary Municipal Development Bureau, Chamber of Commerce, St. Louis, Mo	1920
Emerson, Frank N., Chairman City Planning Committee of Association of Commerce, Peoria, Ill	1918
Farey, F. O., Robert W. Hunt and Co., 905 McGill Building, McGill St., Montreal, Que	1918
Flannigan, E. L., Contractor, Baltimore, Md	1921
Follin, James W., Staff Engineer, Bureau of Municipal Research, 805 Franklin Bank Building, 1417 Sansom St., Philadelphia, Pa	1921
Gay, W. L., Chief Engineer, Southern Clay Manufacturing Co., Chattanooga, Tenn	1920
George, Howard H., Engineer, Maintenance of Way, Public Service Railway Co., 646 Public Service Terminal, Newark, N. J	1921
Hadden, Samuel C., Editor, Municipal and County Engineering, 702 Wulsin Building, Indianapolis, Ind	1920
Hawkins, C. L., Engineer Way and Structures, United Railways Co., 3869 Park Ave., St. Louis, Mo	1920
Hebden, Edwin K., Engineer for Development and Construction Company, 4221 York Road, Baltimore, Md	1921
Jenkins, H. S., The White Company, Cleveland, Ohio	1921
Johnson, Helen M., Director, Municipal Reference Bureau, Galesburg, Ill	1921
Lothrop, G. W., Woonsocket, R. I	1913
Masury, Alfred F., Chief Engineer, and Vice President, International Motor Co., Sixty-fourth and West End Ave., New York City	1917
Nebraska Legislative Reference Bureau, Library Hall, University of Nebraska, Lincoln, Neb., Edna D. Bullock, Librarian, Rep	1919
Newcomb, William T., Consulting Highway Engineer, 710 Drake Bldg., Easton, Pa	1922
Olson, F. L., Director of Municipal Research, Civic and Commerce Association, Minneapolis, Minn	1919
Parlin, R. W., Assistant Manager Public Works Department, International Motor Co., 252 W. 64th St., New York City	1920
Powell, Sheppard T., Chemist, Baltimore County Water and Electric Company, 100 W. Fayette St., Baltimore, Md	1921
Proctor, Ralph F., Engineer Maryland Casualty Co., Baltimore, Md.	1921
Roberts, C. W., Secretary Chamber of Commerce, Bristol, Tenn.-Va.	1919
Robertson, George S., Secretary Engineers' Club, 1628 Linden Ave., Baltimore, Md	1921
Stewart, Frank M., Head of Government Research Division, Instructor in Government, University of Texas, Austin, Tex	1919

Stone, William H., Associate Editor Manufacturers Record, Baltimore, Md. 1919
Story, Stephen B., Director Bureau of Municipal Research, 25 Main Street E., Rochester, N. Y. 1921
Sucro, W. G., Engineer Development and Construction Company, 506 American Building, Baltimore, Md. 1921
Von Schrenk, Hermann, Consulting Timber Engineer, Tower Grove and Flad Aves., St. Louis, Mo. 1914
Wysor, W. W., Chief Engineer, United Railways and Electric Co., 150 Continental Bldg., Baltimore, Md. 1921

ASSOCIATE MEMBERS

Ahrens, Jr., H. F., Rep. Lock Joint Pipe Co., Leonia, N. J. 1921
AMBURSEN CONSTRUCTION COMPANY, INC., Grand Central Terminal, New York City. 1921
  S. W. Stewart, President, Grand Central Terminal, New York City.
AMERICAN CAR SPRINKLER COMPANY, 1 Brussels St., Worcester, Mass. 1917
  E. D. Perry, Asst. Genl. Supt., Box 414, Worcester, Mass.
AMERICAN CITY, THE, 154 Nassau St., New York City. 1913
  Edgar J. Buttenheim, President, 154 Nassau St., New York City.
  Theodore R. Kendall, Editor, 154 Nassau St., New York City.
AMERICAN TAR PRODUCTS COMPANY. 1921
  Wallace E. Crowell, Athletic Club, Columbus, Ohio.
Anderson, A. M., Secretary-Treasurer, Rep. Elgin Sales Corporation, 1340 Old Colony Building, Chicago, Ill.
ASPHALT ASSOCIATION, THE, 25 W. 43d St., New York City. 1919
  J. E. Pennybacker, Secretary, 25 W. 43d St., New York City.
  W. E. Rosengarten, 25 W. 43d St., New York City.
ASPHALT SALES CORPORATION, 128 N. Wells St., Chicago, Ill. 1921
  Fred C. Campbell, 128 N. Wells St., Chicago, Ill.
  H. J. Gillum, President, 128 N. Wells St., Chicago, Ill.
ATLANTIC BITULITHIC COMPANY, 105 Virginia Railway and Power Building, Richmond, Va. 1913
  George O. Tenney, President, 1205 Virginia Railway and Power Building, Richmond, Va.

Bailey, John M., Secretary, Rep. Pittsburg Testing Laboratory, 7th and Bedford Aves., Pittsburg, Pa.
Baker, H. B., Rep. The Holt Manufacturing Company, Peoria, Ill.
Baker, W. D., Rep. Warner-Quinlan Asphalt Co., 79 Wall St., New York City.
BARBER ASPHALT PAVING COMPANY, THE, Land Title Building, Philadelphia, Pa. 1913
  C. N. Forrest, Manager Technical Department, Maurer, N. J.
  J. Strother Miller, Jr., Chief Chemist, Technical Department, Maurer, N. J.
  J. E. Morris, Manager Street and Road Department, Land Title Building, Philadelphia, Pa.
Barbour, J. G., Secretary, Rep. Metropolitan Paving Brick Co., Canton, Ohio.
Barrett, R. R., Assistant Superintendent of Eastern Division, Rep. The Texas Co., Asphalt Sales Department 17 Battery Place, New York City.
BARRETT COMPANY, THE, 40 Rector Street, New York City. 1906
  Walter Buehler, Engineer of Paving and Wood Preservation, 40 Rector St., New York City.
  L. J. Burleigh, 501 Lobe Building, Baltimore, Md.

C. L. Campbell, 705 LaClede Gas Bldg., St. Louis, Mo.
W. H. Caruthers, Manager Paving Department, Fairfield, Ala.
Geo. E. Martin, Highway Engineer, 10 S. LaSalle St., Chicago, Ill.
Philip P. Sharples, Manager Tarvia Department, 40 Rector St., New York City.
B. M. Smith, Manager Paving Department, 10 S. LaSalle St., Chicago, Ill.
Benedict, E. L., Vice-President and Manager of Sales, Rep. National Steel Fabric Co., First National Bank Building, Pittsburg, Pa.
BIRMINGHAM SLAG COMPANY, 1607 Jefferson County Bank Building, Birmingham, Ala.................................. 1920
C. E. Ireland, Sales Manager, 1607 Jefferson County Bank Building, Birmingham, Ala.
S. G. Reynolds, Atlanta Branch Manager, 205 Walton Building, Atlanta, Ga.
BITOSLAG PAVING COMPANY, 10 West St., New York City.... 1922
W. G. Coats, 90 West St., New York City.
Blackmer, A. E., Second Vice-President and Sales Manager, Rep. Blackmer and Post Pipe Co., Boatmen's Bank Building, St. Louis,
BLACKMER AND POST PIPE COMPANY, 1206 Boatmen's Bank Building, St. Louis, Mo...................................... 1912
A. E. Blackmer, Second Vice-President and Sales Manager, Boatmen's Bank Building, St. Louis, Mo.
Blair, Will P., Vice-President, Rep. National Paving Brick Manufacturers' Association, 828-34 B. L. E. Building, Cleveland, Ohio.
BOOTH BROTHERS AND HURRICANE ISLE GRANITE COMPANY 208 Broadway, New York City........................ 1917
Charles Mitchell, Treasurer, New York City.
Bramley, M. F., Pres., Rep. Cleveland Trinidad Paving Co., 886 The Arcade, Cleveland, Ohio.
Buehler, Walter, Engineer of Paving and Wood Preservation, Rep. The Barrett Company, 40 Rector St., New York City.
Burleigh, L. J., Rep. The Barrett Company, 501 Lobe Building, Baltimore, Md.
Burns, Howard E., Rep. Superior Garbage Incinerator Company of Texas, Praetorian Building, Dallas, Texas.
Burrows, Horace E., Pres., Rep. The Modern City Publishing Co., Ten Hills, Md.
Buttenheim, Edgar J., Pres., Rep. The American City, 154 Nassau St., New York City.

Campbell, C. L., District Manager Tarvia Department, Rep. The Barrett Company, 705 Laclede Gas Building, St. Louis, Mo.
Campbell, Fred C., Rep. Asphalt Sales Corporation, 128 N. Wells St., Chicago, Ill.
CANADA CRUSHED STONE CORPORATION, Ltd., Dundas, Ont., Can.. 1919
C. M. Doolittle, Pres. Dundas, Ont., Can.
CARSON PETROLEUM COMPANY, 208 S. LaSalle St., Chicago, Ill.. 1920
James R. Valk, Manager Asphalt and Road Oil Department, 208 S. LaSalle St., Chicago, Ill.
Caruthers, W. H., Manager Paving Department, The Barrett Company, Fairfield, Ala.
Cassidy, J. A., Secretary-Treasurer, Rep. Southern Asphalt Association, 419 Healey Building, Atlanta, Ga.
CINCINNATI QUARRIES COMPANY, 108 Bell Block, Cincinnati, Ohio.. 1921
Geo. W. Doran, Pres., 108 Bell Block, Cincinnati, Ohio.
Clark, James D., Assistant to Vice-President, Rep. Standard Oil Company of Kentucky, Louisville, Ky.
CLAY PRODUCTS ASSOCIATION, 913 Chamber of Commerce, Chicago, Ill.. 1918

George C. D. Lenth, Secretary and General Manager, 913 Chamber of Commerce, Chicago, Ill.

CLEVELAND TRINIDAD PAVING COMPANY, 886 The Arcade, Cleveland, Ohio.. 1915

M. F. Bramley, Pres., 886 The Arcade, Cleveland, Ohio.

Clews, Harry T., Secretary, Rep. The Tomkins Cove Stone Company, 30 Church St., New York City.

Coats, W. G., Rep. Bitoslag Paving Co., 90 West St., New York City.

Craven, Jr., William D., Engineer, Asphalt Paving and Road Construction Rep. Standard Oil Company (New York) Room 1306, 26 Broadway, New York City.

CRESSY ROAD SPRAYER MANUFACTURING COMPANY, 462 Second St., Everett, Mass.................................... 1920

Richard R. Pebworth, Pres. 462 Second St., Everett, Mass.

Crowell, W. E., Rep. American Tar Products Co., Atheltic Club, Columbus, Ohio.

Cutter, Frank G., Rep. Warren Brothers Co., Assistant to President, 848 Otis Building, Chicago, Ill.

DeBerard, W. W., Western Editor, Rep., Engineering News-Record, 1570 Old Colony Building, Chicago, Ill.

Dickey, W. S., Rep. W. S. Dickey Clay Manufacturing Company, 200 New York Life Building, Kansas City, Mo.

DICKEY, W. S. CLAY MANUFACTURING COMPANY, 200 New New York Life Bldg., Kansas City, Mo........................ 1921

W. S. Dickey, President, 200 New York Life Bldg., Kansas City, Mo.

D'Olier, William L., Chief Engineer, Rep. The Sanitation Corporation, 1533 Girard Ave., Philadelphia, Pa.

Doolittle, C. M., Rep. Canada Crushed Stone Corporation, Dundas, Ont.

Doran, George W., Pres., Rep. The Cincinnati Quarries Co., 108 Bell Block, Cincinnati, Ohio.

DORR COMPANY, THE, 101 Park Ave., New York City......... 1920

J. S. Sherman, Chief Municipal Sewage Section, 101 Park Ave., New York City.

DOW CHEMICAL COMPANY, THE, Midland, Mich............ 1920

S. W. Putnam, Midland, Mich.

Draney, J. R., General Sales Manager, Rep. The U. S. Asphalt Refining Co., 90 West St., New York City.

Dunn, Frank B., Pres. Rep. Dunn Wire-Cut Lug Brick Co., Conneaut, Ohio.

DUNN WIRE-CUT LUG BRICK COMPANY, Conneaut, Ohio..... 1911

Frank B. Dunn, President, Conneaut, Ohio.

J. C. Travilla, Consulting Engineer, Room 1018, 211 N. 7th St., St. Louis, Mo.

DUSTOLINE FOR ROADS COMPANY, Summit, N. J............ 1917

Edwin R. Lamson, President, Summit, N. J.

Duty, Spencer M., Pres., Rep. Medal Paving Brick Co., 4900 Euclid Ave., Cleveland, Ohio.

EASTERN CLAY PRODUCTS ASSOCIATION, 514-5 Pittsburg Life Building, Pittsburg, Pa.. 1920

H. T. Shelley, Secretary, 514-5 Pittsburg Life Building, Pittsburg, Pa.

EASTERN PAVING BRICK MANUFACTURERS' ASSOCIATION, Lincoln Building, Philadelphia, Pa.................... 1920

W. C. Perkins, Secretary, 412 Lincoln Building, Philadelphia, Pa.

Ege, C. R., Engineer Road Bureau, Rep. Portland Cement Association, 111 W. Washington St., Chicago, Ill.

Elder, R. M., Assistant Superintendent Mid-West Division, Rep. The Texas Company, 540 Otis Building, Chicago, Ill.

ELGIN SALES CORPORATION, 1340 Old Colony Building, Chicago, Ill.. 1920

A. M. Anderson, Secretary-Treasurer, 1340 Old Colony Building, Chicago, Ill.
ENGINEERING NEWS RECORD, 10th Ave., and 36th St., New York City 1920
R. K. Tomlin, Managing Editor, 10th Ave., and 36th St., New York City.
W. W. DeBerard, Western Editor, 1570 Old Colony Building, Chicago, Ill.

Ferguson, W. C., Rep. Ferguson Segment Block Company, 1802 Arcade Building, St. Louis, Mo.
FERGUSON SEGMENT BLOCK COMPANY, 1802 Arcade Building, St. Louis, Mo 1919
W. C. Ferguson, President, 1802 Arcade Building, St. Louis, Mo.
Fisher, Henry, Manager Road Oil Department, Rep. Standard Oil Company of New York, Room 600, 26 Broadway, New York City.
Forrest, C. N., Manager Technical Department, Rep. The Barber Asphalt Paving Co., Maurer, N. J.
FRANCO-AMERICAN,WOOD TRANSFORMATION CORPORATION, 131 Church St., Wallingford, Conn 1921
Arthur C. Smith, Chief Engineer, 112 S. Whittlesey Ave., Wallingford, Conn.
FRANKLIN CONTRACTING COMPANY, 20 Washington Place, Newark, N. J 1921
J. H. Rainsbury, 20 Washington Place, Newark, N. J.
Alex Reed, 20 Washington Place, Newark, N. J.
Fulweiler, W. H., Chemist, Rep. The United Gas Improvement Co., 1706 N. Broad St., Philadelphia, Pa.

Gartland, Jr., John J., Superintendent Eastern Division, Rep. The Texas Co., Asphalt Sales Dept., Whitehall Building, 17 Battery Place, New York City.
Gay, Louis W., Rep. The Texas Co., 17 Battery Place, New York City.
Gillum, H. J., Pres., Rep. Asphalt Sales Corporation, 128 N. Wells St., Chicago, Ill.
GRANITE PAVING BLOCK MANUFACTURERS' ASSOCIATION OF THE UNITED STATES, 31 State St., Boston, Mass. 1915
J. J. Tobin, Secretary, 31 State St., Boston, Mass.
F. T. Mason, 311 Atlanta Trust Building, Atlanta, Ga.
Greenough, Maurice B., Secretary, Rep. National Paving Brick Mfgrs. Assn., 830 B. L. E. Building, Cleveland, Ohio.

Haff, Robert W., Pres., Rep. Inland Engineering Corporation, 15 William St., New York City.
Hall, John W., Rep. Westport Paving Brick Co., Westport, Baltimore, Md.
HARRIS GRANITE QUARRIES COMPANY, Salisbury, N. C 1915
R. G. Hunt, Drawer 267, Salisbury, N. C.
HASTINGS PAVEMENT COMPANY, 25 Broad St., New York City. 1920
P. L. Thompson, Sales Manager, 25 Broad St., New York City.
T. J. McNally, 25 Broad St., New York City.
Helm, J. S., Rep. Standard Oil Co. of Louisiana, Whitney Central Bldg., New Orleans, La.
Hempelmann, W. L., Engineer of Middle West Division, Rep. The Texas Co., Asphalt Dept., 540 Otis Building, 10 S. LaSalle St., Chicago, Ill.
Hess, Lawrence E., Rep. Republic Creosoting Company, Merchants Bank Building, Indianapolis, Ind.
Hildreth, H. V., General Manager, Rep. Hildreth Granite Co., 31 State St., Boston, Mass.
HILDRETH GRANITE COMPANY, 31 State St., Boston, Mass 1914
H. V. Hildreth, General Manager, 31 State St., Boston, Mass.
Hirsch, Allen M., Pres., Rep. Lock Joint Pipe Co., P. O. Box 21, Ampere, N. J.

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Hogan, F. A., Asphalt & Road Oil Dept., Rep. Imperial Oil Co., Ltd., 56 Church St., Toronto, Ont., Canada.
HOLT MANUFACTURING COMPANY, THE, Peoria, Ill........ 1920
H. B. Baker, Peoria, Ill.
Hunt, R. G., Rep. Harris Granite Quarries Co., Drawer 267, Salisbury, N. C.

IDEAL POWER LAWN MOWER COMPANY, Lansing, Mich..... 1920
E. H. Peters, Manager Chicago Branch, 533 S. Dearborn St., Chicago, Ill.
IMPERIAL OIL COMPANY, LTD., 56 Church St., Toronto, Ont. Canada.. 1917
F. A. Hogan, Asphalt & Road Oil Department, 56 Church St., Toronto, Ont., Canada.
INLAND ENGINEERING CORPORATION, 15 William St., New York City.. 1921
Robert W. Haff, President, 15 William St., New York City.
Ireland, C. E., Sales Manager, Rep. Birmingham Slag Co., 1607 Jefferson County Bank Building, Birmingham, Ala.

Johnson, Alfred H., President, Rep. Texas Bitulithic Company, Praetorian Building, Dallas, Texas.

Kaull, Pardon S., Vice-President, Rep. Warren Brothers Company, Railway Exchange Building, St. Louis, Mo.
Kelly, J. M., Secretary, Rep. The Sanitation Corporation, 165 Broadway, New York Cty.
Kemp, Louis W., Superintendent Southwestern Division, Asphalt Sales Department, Rep. The Texas Company, Houston, Texas.
Kendall, Theodore Reed, Editor, Rep. The American City, 154 Nassau St., New York City.
Kennedy, Dennis A., Superintendent of New England Division, Rep. The Texas Co., Asphalt Sales Dept. 714 Tremont Bldg., 73 Tremont St., Boston, Mass.
KENTUCKY ROCK ASPHALT COMPANY, Paul Jones Building, Louisville, Ky.. 1920
Rodman Wiley, Chief Engineer, Paul Jones Building, Louisville, Ky.
Kershaw, W. H., Mgr., Rep. The Texas Co., Asphalt Sales Dept., 1904 Whitehall Bldg., 17 Battery Place, New York City.

Lamson, Edwin R., Pres., Rep. Dustoline for Roads Co., Summit, N. J.
LAMSON, GEORGE W., 701 Railway Exchange Bldg., Chicago, Ill... 1911
Larkin, A. E., Rep. Republic Creosoting Co., Box 274, St. Louis Park, Minn.
Law, Leroy M., Chief Chemist, Rep. New Orleans Refining Co., 309 Maison Blanche Annex, New Orleans, La.
Lenth, George C. D., Sec., Rep. Clay Products Association, 913 Chamber of Commerce Building, Chicago, Ill.
Leopold, J. L., Rep. J. Leopold & Co., 233 Broadway, New York City.
LEOPOLD AND COMPANY, J., 233 Broadway, New York City.... 1915
J. L. Leopold, 233 Broadway, New York City.
Lewis, F. J., Pres., Rep. F. J. Lewis Mfg. Co., 2500 S. Robey St., Chicago, Ill.
LEWIS MANUFACTURING COMPANY, F. J., 2500 S. Robey St., Chicago, Ill.. 1920
F. J. Lewis, President, 2500 S. Robey St., Chicago, Ill.
Libberton, J. H., Manager Service Bureau, Rep. Universal Portland Cement Company, 210 S. LaSalle St., Chicago, Ill.
Lippincott, J. H., District Manager, Rep. Warren Bros. Co., 50 Church St., New York City.
LOCK JOINT PIPE COMPANY, East Orange, N. J............... 1908
Allen M. Hirsh, President, P. O. Box 21, Ampere, N. J.
H. F. Ahrens, Jr., Leonia, N. J.

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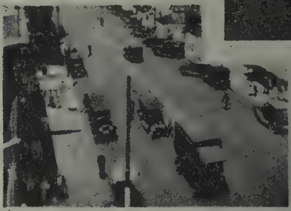
Mackendrick, W. G., President, Rep. Warren Bituminous Paving Company, Toronto, Ont., Can.
Mandigo, Clark R., Engineer, Rep. Western Paving Brick Manufacturers' Association, 317 Dwight Building, Kansas City, Mo.
Manning, F. L., General Manager, Rep. Peebles Paving Brick Company, Portsmouth, O.
Marker, J. R., Secretary, Rep. Ohio Paving Brick Manufacturers' Association, 507 Hartman Building, Columbus, O.
Martin, George E., Consulting Engineer, Rep. The Barrett Company, 10 S. LaSalle St., Chicago, Ill.
Mason, Frank T., Rep. Granite Paving Block Manufacturers' Association, 311 Atlanta Trust Building, Atlanta, Ga.
Mason, L. R., Rep. Southern Willite Paving Co., 815 E. Franklin St., Richmond, Va.
McCandless, Wm. W., Rep. The Sanitation Corporation, 165 Broadway, New York City.
McCormick, Porter S., Asphalt Rep. Standard Oil Company (New Jersey), Baltimore, Md.
McNally, T. J., Rep. The Hastings Pavement Co., 25 Broad St., New York City.
McNeil, Donald, Rep. Donald McNeil Company, Jenkins Arcade Building, Pittsburg, Pa.
MCNEIL COMPANY, DONALD, Jenkins Arcade Building, Pittsburg, Pa. 1915
Donald McNeil, Jenkins Arcade Building, Pittsburg, Pa.
MEDAL PAVING BRICK COMPANY, THE, 4900 Euclid Ave., Cleveland, O. 1911
Spencer M. Duty, President, 4900 Euclid Ave., Cleveland, O.
METROPOLITAN PAVING BRICK COMPANY, THE, Canton, O. 1911
J. G. Barbour, Secretary, Canton, O.
Miller, Jr., J. Strother, Chief Chemist, Technical Dept., Rep. The Barber Asphalt Paving Co., Maurer, N. J.
Miller, S. Fisher, Pres., Rep. Pacific Flush Tank Co., 149 Broadway, New York City.
Mitchell, Charles, Pres., Rep. Booth Bros. and Hurricane Isle Granite Co., 208 Broadway, New York City.
MODERN CITY PUBLISHING COMPANY, 43 Franklin Building, Baltimore, Md. 1921
Horace E. Burrows, Pres., Ten Hills, Md.
Morris, J. E., Manager Street and Road Department, Rep. The Barber Asphalt Paving Co., Land Title Building, Philadelphia, Pa.
Murphy, Charles E., Rep. The Texas Company, 17 Battery Place, New York City.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION, 828-834 Brotherhood of Locomotive Engineers' Bldg. Cleveland, Ohio 1907
Will P. Blair, Vice-President, 828-34 B. L. E. Bldg., Cleveland, O.
Maurice B. Greenough, Secretary, 830 B. L. E. Bldg., Cleveland, O.
O. W. Renkert, President, Renkert Building, Canton, O.
W. H. Lucktenberg, The Burton-Townsend Co., Zanesville, O.
NATIONAL STEEL FABRIC COMPANY, First National Bank Building, Pittsburg, Pa. 1920
E. L. Benedict, Vice-President and Manager Sales, First National Bank Building, Pittsburg, Pa.
Newbold, C. L., Rep. Warren Brothers Company, 1859 Railway Exchange Bldg., St. Louis, Mo.
NEW ORLEANS REFINING COMPANY, INC., 309 Maison Blanche Annex, New Orleans, La. 1920



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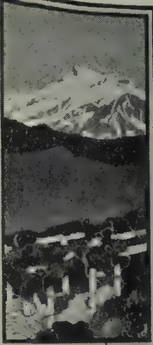
Leroy M. Law, Chief Chemist, 309 Maison Blanche Annex, New Orleans, La.
NEW YORK TRAP ROCK CORPORATION, 101 Park Ave., New York City.. 1918
Mortimer D. Wandell, Vice-President, 101 Park Ave., New York City.

OHIO PAVING BRICK MANUFACTURERS' ASSOCIATION, 507 Hartman Building, Columbus, Ohio........................ 1919
J. R. Marker, Secretary, 507 Hartman Building, Columbus, Ohio.

PACIFIC FLUSH TANK COMPANY, 4241 E. Ravenswood Ave., Chicago, Ill. and Singer Building, New York City............... 1915
S. Fisher Miller, Pres., 149 Broadway, New York City.
E. L. Walcott, 4241 Ravenswood Ave., Chicago, Ill.
Pebworth, Richard R., Pres., Rep., Cressy Road Sprayer Mfg. Co., 462 Second St., Everett, Mass.
PEEBLES PAVING BRICK COMPANY, Portsmouth, Ohio....... 1912
F. L. Manning, General Manager, Portsmouth, Ohio.
Pennybacker, J. E., Secretary, Rep. The Asphalt Association, 25 W. 43d St., New York City.
Perkins, G. Howard, Assistant to President, Rep., Warren Brothers Co., 9 Cambridge St., Boston, Mass.
Perkins, W. C., Sec., Rep. Eastern Paving Brick Manufacturers' Association, 412 Lincoln Building, Philadelphia, Pa.
Perry, E. D., Assistant General Superintendent, Rep. American Car Sprinkler Company, Box 414, Worcester, Mass.
Peters, E. H., Manager Chicago Branch, Rep. Ideal Power Lawn Mower Co., 533 S. Dearborn St., Chicago, Ill.
PIONEER ASPHALT COMPANY, Lawrenceville, Ill.............. 1915
H. B. Pullar, Vice-President, Lawrenceville, Ill.
PITTSBURG TESTING LABORATORY, 7th and Bedford Aves., Pittsburg, Pa.. 1919
John M. Bailey, Secretary, 7th and Bedford Aves., Pittsburg, Pa.
PORTLAND CEMENT ASSOCIATION, 111 W. Washington St., Chicago, Ill.. 1919
C. R. Ege, Engineer Road Bureau, 111 Washington St., Chicago, Ill.
Pullar, H. B., Vice-President and General Manager, Rep. Pioneer Asphalt Company, Lawrenceville, Ill.
Putnam, S. W., Rep. The Dow Chemical Co., Midland, Mich.

Rainsbury, J. H., Rep. Franklin Contracting Co., 20 Washington Place, Newark, N. J.
Read, Frank C., Head Chemist, Rep. Standard Oil Company of Louisiana, Box 249, Baton Rouge, La.
Reed, Alex, Rep. Franklin Contracting Company, 20 Washington Place, Newark, N. J.
Reed, T. H., Superintendent of Southern Division, Rep. The Texas Co., Asphalt Sales Dept., Jacksonville, Fla.
Reilly, P. C., Pres., Rep. Republic Creosoting Co., Merchants Bank Building, Indianapolis, Ind.
Renkert, O. W., President, Rep. National Paving Brick Manufacturers Association, Renkert Building, Canton, Ohio.
REPUBLIC CREOSOTING COMPANY, Merchants Bank Bldg., Indianapolis, Ind.. 1907
P. C. Reilly, President, Merchants Bank Building, Indianapolis, Ind.
A. E. Larkin, Box 274, St. Louis Park, Minn.
L. E. Hess, Merchants Bank Building, Indianapolis, Ind.
Reynolds, S. G., Atlanta Branch Manager, Rep. Birmingham Slag Company, 205 Walton Bldg., Atlanta, Ga.
Robinson, E. M., District Manager, Rep. Warren Bros. Co., 1414 Bank of Commerce, Memphis, Tenn.



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ROCKPORT GRANITE COMPANY, Rockport, Mass............. 1915
  C. Harry Rogers, Rockport, Mass.
Rogers, C. Harry, Rep. Rockport Granite Co., Rockport, Mass.
Rosengarten, W. E., Rep. The Asphalt Association, 25 W. 43d St., New York City.

SAINT MARYS SEWER PIPE COMPANY, St. Marys, Pa........ 1910
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  Wm. W. McCandless, 165 Broadway, New York City.
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Sherrick, Edward D., Assistant Superintendent Asphalt Sales Dept., Rep., The Texas Company, 210 Dwight Bldg., Kansas City, Mo.
Smith, Arthur C., Chief Engineer, Rep., Franco-American Wood Transformation Corp., 112 Whittlesey Ave., Wallingford, Conn.
Smith, B. M., Manager Tarvia Department, Rep. The Barrett Company, 10 S. LaSalle St., Chicago, Ill.
SOUTHERN ASPHALT ASSOCIATION, 419 Healey Building, Building, Atlanta, Ga.................................... 1919
  J. A. Cassidy, Secretary-Treasurer, 419 Healey Bldg., Atlanta, Ga.
SOUTHERN WILLITE PAVING COMPANY, 815 Franklin St., Richmond, Va.. 1921
  L. R. Mason, Jr., Richmond, Va.
Spencer, Herbert, Asphalt Department, Rep. Standard Oil Company (New Jersey) Room 1107, 26 Broadway, New York.
STANDARD OIL COMPANY OF KENTUCKY, Louisville, Ky.... 1919
  James D. Clark, Assistant to Vice-President, Louisville, Ky.
STANDARD OIL COMPANY OF LOUISIANA, Whitney Central Building, New Orleans, La................................. 1915
  J. S. Helm, Whitney Central Building, New Orleans, La.
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STANDARD OIL COMPANY (NEW JERSEY), 26 Boradway, New York.
  Porter S. McCormick, Asphalt Rep. Baltimore, Md.
  Herbert Spencer, Engineer Asphalt Department, 26 Broadway, Room 1107, New York City.
STANDARD OIL COMPANY OF NEW YORK, Room 600, 26 Broadway, New York City.................................. 1913
  Henry Fisher, Manager Road Oil Department, Room 600, 26 Broadway, New York City.
  Wm. D. Craven, Jr., Engineer Asphalt Pavement & Road Construction, Room 1306, 26 Broadway, New York City.
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SUPERIOR GARBAGE INCINERATOR COMPANY OF TEXAS, Praetorian Building, Dallas, Texas.......................... 1919
  H. E. Burns, Praetorian Building, Dallas, Texas.

Tenney, George O., President, Rep. Atlantic Bitulithic Company, 1205 Virginia Railway and Power Building, Richmond, Va.
TEXAS BITULITHIC COMPANY, Praetorian Building, Dallas, Tex. 1908
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TEXAS COMPANY, THE Asphalt Sales Department, 17 Battery Place, New York City..................................... 1911

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TOMKINS COVE STONE COMPANY, 30 Church St., New York City.. 1921

Harry T. Clews, Secretary, 30 Church St., New York City.

Tomlin, R. K., Managing Editor, Rep. Engineering News-Record, 10th Ave., and 36th St., New York City.

Travilla, J. C., Consulting Engineer, Rep. Dunn Wire-Cut Lug Brick Company, Room 1018, 211 N. 7th St., St. Louis, Mo.

UNITED GAS IMPROVEMENT COMPANY, THE, 1706 N. Broad St., Philadelphia, Pa.. 1913

W. H. Fulweiler, Chemist, 1706 N. Broad St., Philadelphia, Pa.

UNITED STATES ASPHALT REFINING COMPANY, THE, 90 West St., New York City.. 1913

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UNIVERSAL PORTLAND CEMENT COMPANY, 210 S. LaSalle St., Chicago, Ill.. 1913

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Valk, James R., Manager Asphalt and Road Oil Department, Carson Petroleum Co., 208 S. LaSalle St., Chicago, Ill.

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WARREN BROTHERS COMPANY, Parkman Bldg., 9 Cambridge St., Bowdoin Square, Boston, Mass. 1905
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West, L. B., Pres., Rep. West Construction Company, Kinston, N. C.

WEST CONSTRUCTION COMPANY, Kinston, N. C. 1921
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WESTERN PAVING BRICK MANUFACTURERS' ASSOCIATION, 317 Dwight Building, Kansas City, Mo. 1912
George W. Thurston, Secretary, 317 Dwight Building, Kansas City, Mo.
Clark R. Mandigo, Engineer, 317 Dwight Building, Kansas City, Mo.

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, South Bend, Ind. 1921
L. A. S. Wood, South Bend, Ind.

WESTPORT PAVING BRICK COMPANY, Westport, Baltimore, Md. 1921
John W. Hall, Westport, Baltimore, Md.

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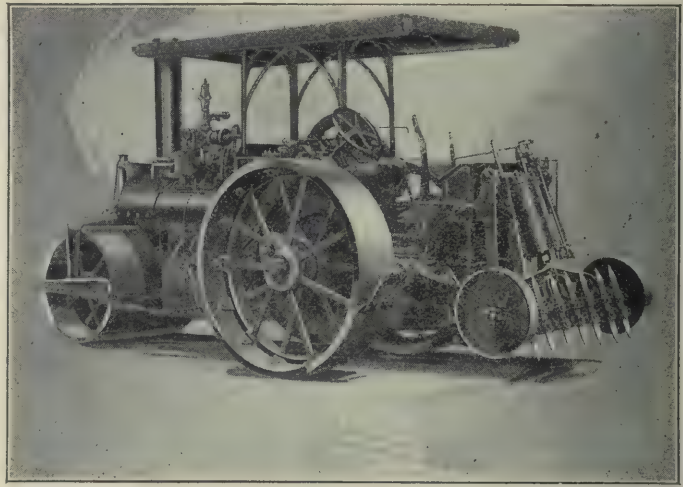

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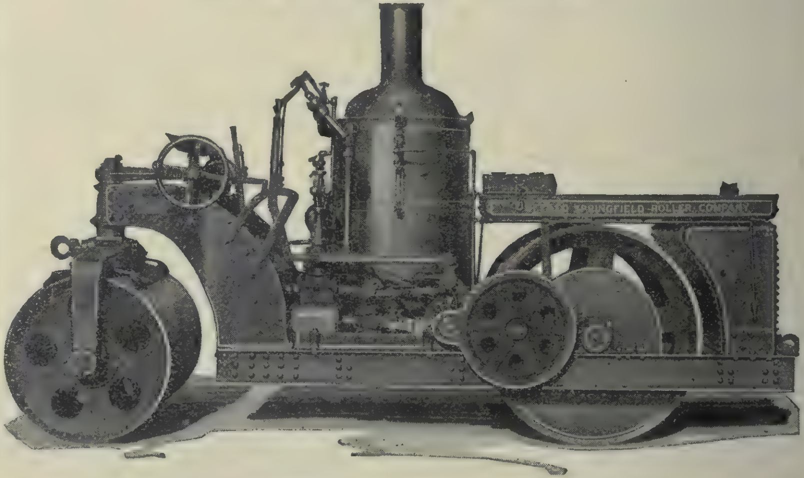

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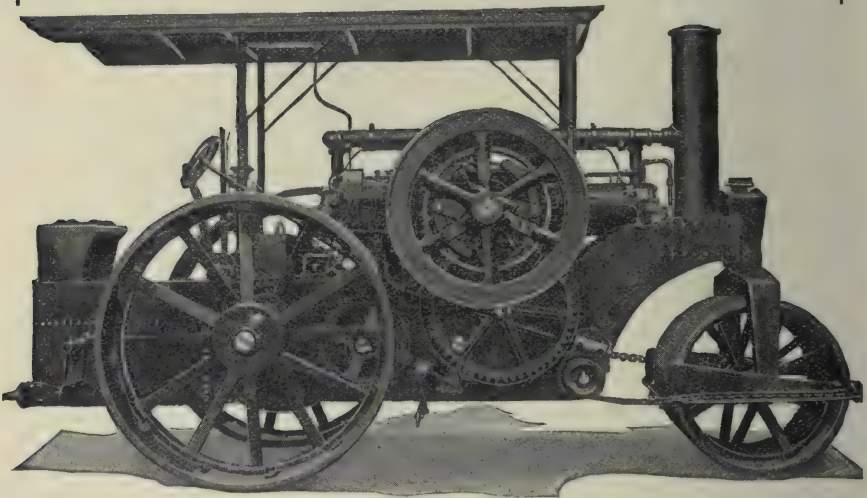

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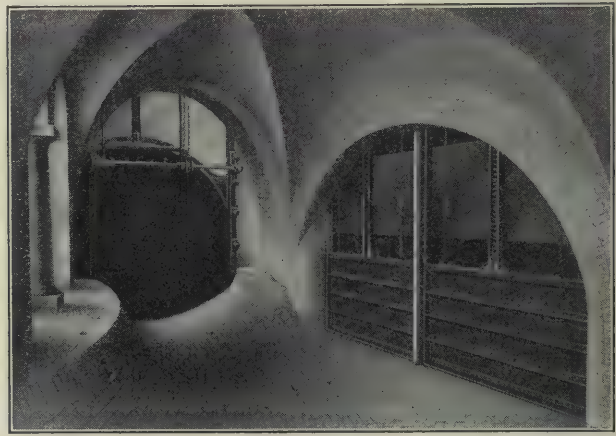

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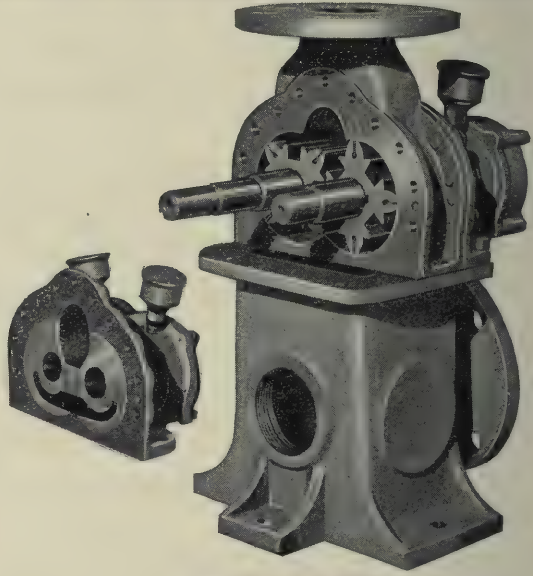

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